

SECTION 6 HAZARD AVOIDANCE

Hazard avoidance features available for the system are designed to aid situational awareness and provide advisory information with regard to potential hazards to flight safety associated with weather, terrain, and air traffic.

Weather

- GDL 69/69A or 69/69A SXM SiriusXM Weather (Subscription Optional)
- Flight Information Services-Broadcast (FIS-B) (Optional)
- L-3 WX-500 Stormscope® Lightning Detection System

Terrain Avoidance

- Terrain Proximity
- Terrain-SVT (included with Garmin SVT option)
- Terrain Awareness and Warning System Class-B (TAWS-B)

Traffic

- Traffic Information Service (TIS)
- Garmin GTS 800 or Honeywell KTA 870 Traffic Advisory System (TAS) Traffic (Optional)
- Automatic Dependent Surveillance-Broadcast (ADS-B) Traffic (Optional)

6.1 DATA LINK WEATHER



WARNING: Do not use data link weather information for maneuvering in, near, or around areas of hazardous weather. Information contained within data link weather products may not accurately depict current weather conditions.



WARNING: Do not use the indicated data link weather product age to determine the age of the weather information shown by the data link weather product. Due to time delays inherent in gathering and processing weather data for data link transmission, the weather information shown by the data link weather product may be older than the indicated weather product age.

The Data Link Weather feature enables the system to receive weather information from a variety of weather sources, depending on the equipment installed in the aircraft. These sources may include SiriusXM Weather and Flight Information Services-Broadcast (FIS-B). For each source, a ground-based system processes the weather information collected from a network of sensors and weather data providers.

The SiriusXM Weather service, available with the Garmin GDL 69A and 69A SXM data link receiver and an active service subscription, updates its weather data periodically and automatically, and transmits this information to the aircraft's receiver via satellite on the S-Band frequency. This service provides continuous reception capabilities at any altitude throughout North America. Differences in performance between the GDL 69A and 69A SXM data link receiver models, where relevant, are discussed where applicable in this section.

The FIS-B Weather service, available when equipped with a capable transponder which can receive 978 MHz Universal Access Transceiver (UAT) data, delivers subscription-free weather information periodically and automatically to the aircraft. FIS-B uses a network of FAA-operated Ground-Based Transceivers (GBTs) to transmit the information to the aircraft's receiver. Reception is limited to line-of-sight, and is available below 24,000 feet MSL in the United States. FIS-B broadcasts provide weather data in a repeating cycle which may take approximately ten minutes to transmit all available weather data. Therefore, not all weather data may be present immediately upon initial FIS-B signal acquisition. FIS-B is a component of the Automatic Dependent Surveillance (ADS-B) system, which offers both weather and traffic data; refer to the ADS-B Traffic discussion later in this section for a more detailed discussion of the ADS-B system and its capabilities.

ACTIVATING DATA LINK WEATHER SERVICES



NOTE: Service activation is not applicable to the FIS-B Weather service.

ACTIVATING THE SIRIUSXM WEATHER SERVICE

Before SiriusXM Weather can be used, the service must be activated by providing SiriusXM's customer service the coded ID(s) unique to the installed data link receiver. The Data Radio ID must be provided to activate the weather service. A separate Audio Radio ID, if present, enables the receiver to provide SiriusXM Radio entertainment. To view this information, refer to the following locations:

- The Aux - XM Information Page on the MFD
- The SiriusXM Activation Instructions included with the Data Link Receiver
- The label on the back of the Data Link Receiver

SiriusXM uses the coded IDs to send an activation signal that allows the system to display weather data and/or provide audio entertainment programming through the data link receiver.

Establishing an account for SiriusXM services:

- 1) Select the XM Radio Page in the Auxiliary Page Group.
- 2) If necessary, press the **Info** Softkey to display the Aux - XM Information Page.
- 3) Note the Data Radio ID (for SiriusXM Weather data) and/or the Audio Radio ID (for SiriusXM Satellite Radio).
- 4) Contact SiriusXM customer service through the phone number listed on its website, www.siriusxm.com.
- 5) Provide SiriusXM customer service the Data Radio ID and/or Audio Radio ID, in addition to payment information, and the desired weather product subscription package.

After SiriusXM has been contacted, it may take approximately 15 minutes until the activation occurs.

Verifying the SiriusXM Weather service activation:

- 1) Once a SiriusXM Weather account has been established, select the XM Radio Page in the Auxiliary Page Group.
- 2) If necessary, press the **Info** Softkey to display the Aux - XM Information Page.
- 3) View the list of supported Weather Products. A white empty box appears next to an unavailable weather product; a green filled box appears next to an available weather product. During activation, it may take several minutes for weather products in the selected subscription package to become available.



NOTE: Not all weather products offered by SiriusXM are supported for display on this system. This pilot's guide only discusses supported weather products.



Figure 6-1 XM Information Page

WEATHER PRODUCT AGE

Unlike real-time weather information collected directly from weather sensors on-board an aircraft, such as an airborne weather radar or a lightning detection system, data link weather by contrast relies on service providers to collect, process, and transmit weather information to the aircraft. This information can come from a variety of sources such as government agencies. Due to the time it takes to collect, process, and distribute data link weather information, it is imperative for pilots to understand that data link weather information is not real-time information and may not accurately depict the current conditions.

For each data link weather product which can be displayed as a map overlay, such as METARs, the system can also show a weather product age. This age represents the elapsed time, in minutes, since the weather service provider compiled the weather product and the current time. It does not represent the age of the information contained within the weather product itself. For example, a single mosaic of radar precipitation is comprised of data from multiple radar sites providing data at differing scan rates or intervals. The weather service provider periodically compiles this data to create a single composite image, and assigns one time to this image which becomes the basis of the product age. The service provider then makes this weather product available for data link transmission at the next scheduled update time. The actual age of the weather data contained within the mosaic is therefore older than its weather product age and should never be considered current.

SiriusXM and FIS-B weather products are broadcast automatically on a repeating cycle without pilot intervention.

Each data link weather product age has an expiration time. The weather product age is shown in white if it is less than half of this expiration time, otherwise it is shown in amber until reaching its expiration time. After a weather product has expired, the system removes the expired weather product from the displays, and shows white dashes instead of the age. If the data link receiver has not yet received a weather product 'N/A' appears instead of the age to show the product is currently not available for display. This may occur, for example, after powering on the system but before the data link receiver has received a complete weather data transmission. It could also indicate a possible outage of a weather product.

The weather product age is shown automatically for weather products displayed on MFD maps. For PFD maps, the pilot can manually enable/disable the age information.

Enabling/disabling the weather product age for PFD Maps:

- 1) Press the **Map/HSI** Softkey.
- 2) Press the **Layout** Softkey.
- 3) Press the **WX LGND** to show/remove the weather product age information for PFD maps.
- 4) Press the **Back** Softkey twice to return to the top-level softkeys.

Tables 6-1 and 6-2 show the weather product symbols, the expiration times and the broadcast rates for SiriusXM Weather and FIS-B Weather, respectively. The broadcast rate represents the interval at which the SiriusXM Weather service transmits new signals that may or may not contain updated weather product information. It does not represent the rate at which the weather information is updated or when the Data Link Receiver receives new data. The service provider and its weather data suppliers define and control the data update intervals, which are subject to change.

SiriusXM Weather Product	Symbol	Expiration Time (Minutes)	Broadcast Rate (Minutes)
NEXRAD		30	5 (U.S.) 10 (Canada)
Cloud Top (CLD TOP)		60	15 (69/69A) 30 (69/69A SXM)
Echo Top (ECHO TOP)		30	7.5
SiriusXM Lightning (LTNG)		30	5
Cell Movement		30	1.25
SIGMETs/AIRMETs		60	12
METARs		90	12
City Forecast		90	12
Surface Analysis		60	12
Freezing Levels		120	12
Winds Aloft		90	12
County Warnings		60	5
Cyclone Warnings		60	12
Icing Potential (CIP and SLD)		90	22
Pilot Weather Report (PIREP)		90	12
Air Report(AIREP)		90	12
Turbulence		180	12
Radar Coverage Not Available	No product image	30	5
Temporary Flight Restriction (TFR)	No product image	60	12
Terminal Aerodrome Forecast (TAF)	No product image	60	12

Table 6-1 SiriusXM Weather Product Symbols and Data Timing

FIS-B Weather Product	Symbol	Expiration Time (Minutes)	Broadcast Rate (Minutes)
NEXRAD Composite (US)		30	15
NEXRAD Composite (Regional)		30	2.5
METARs		90	5
Pilot Weather Report (PIREP)		90	10
Winds Aloft		90	10
SIGMETs/AIRMETs		60	5
No Radar Coverage	no product image	30	2.5
Terminal Aerodrome Forecast (TAF)	no product image	60	10
Temporary Flight Restriction (TFR)	no product image		10

Table 6-2 FIS-B Weather Product Symbols and Data Timing

DISPLAYING DATA LINK WEATHER PRODUCTS

WEATHER DATA LINK PAGE

The Map - Weather Data Link (XM/FIS-B) Page is the principal map page for viewing data link weather information. This page provides the capability for displaying the most data link weather products of any map on the system. The Weather Data Link Page also provides system-wide controls for selecting the data link weather source, if more than one source has been installed. The page title indicates the selected data link weather source (e.g., “XM”, “FIS-B”).

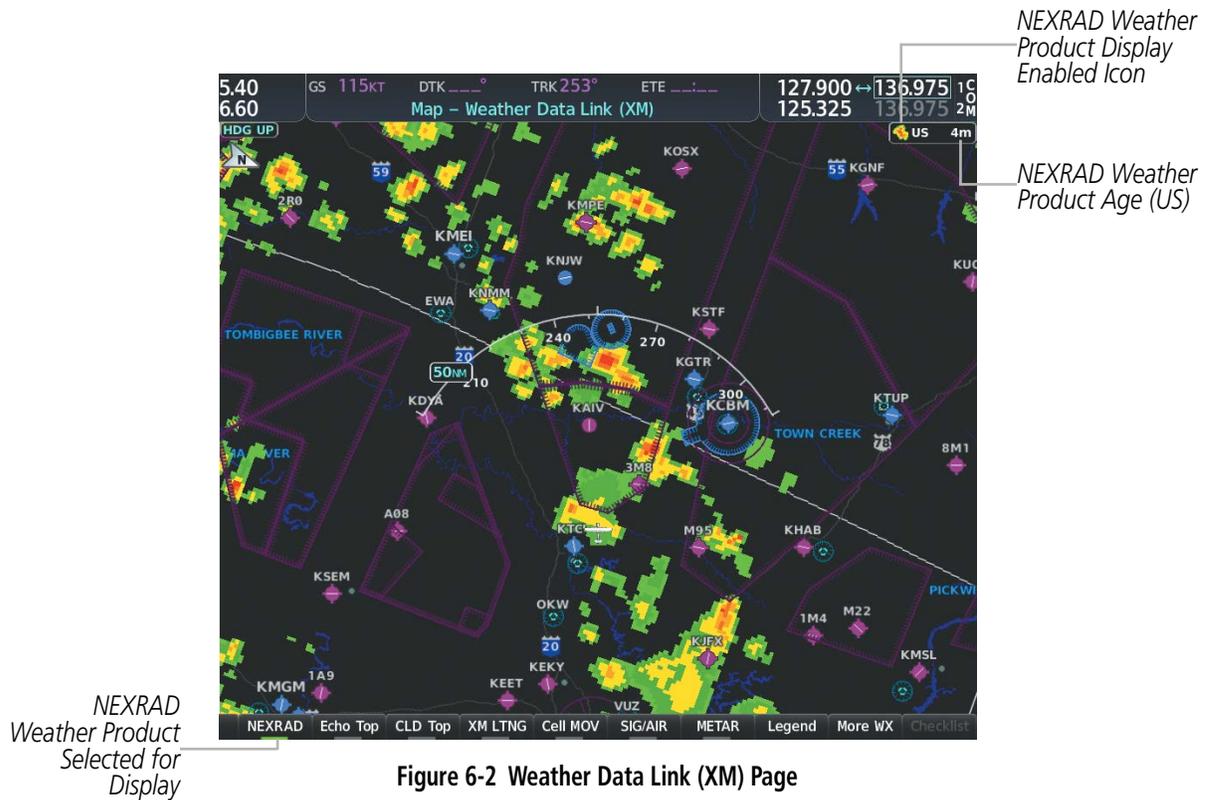


Figure 6-2 Weather Data Link (XM) Page

Viewing the Weather Data Link Page and changing the data link weather source, if applicable:

- 1) Turn the large **FMS** Knob to select the Map Page Group.
- 2) Turn the small **FMS** Knob to select the Weather Data Link (XM or FIS-B) Page. The currently selected data link weather source appears in the page title.
- 3) If the page title does not contain the desired weather source, press the **MENU** Key.
 - a) Turn the **FMS** Knob to highlight 'Display XM Weather', or 'Display FIS-B Weather' (choices may vary depending on the installed equipment).
 - b) Press the **ENT** Key.

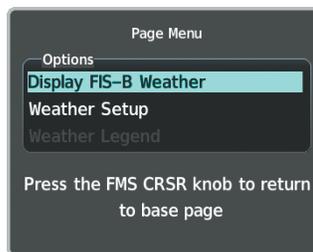


Figure 6-3 Changing the Data Link Weather Source

The system presents the softkeys for the selected source on the Weather Data Link Page, and for map overlays used throughout the system. The following figures show the softkeys for the Weather Data Link Page based on the selected source.

WEATHER DATA LINK (XM) PAGE SOFTKEYS

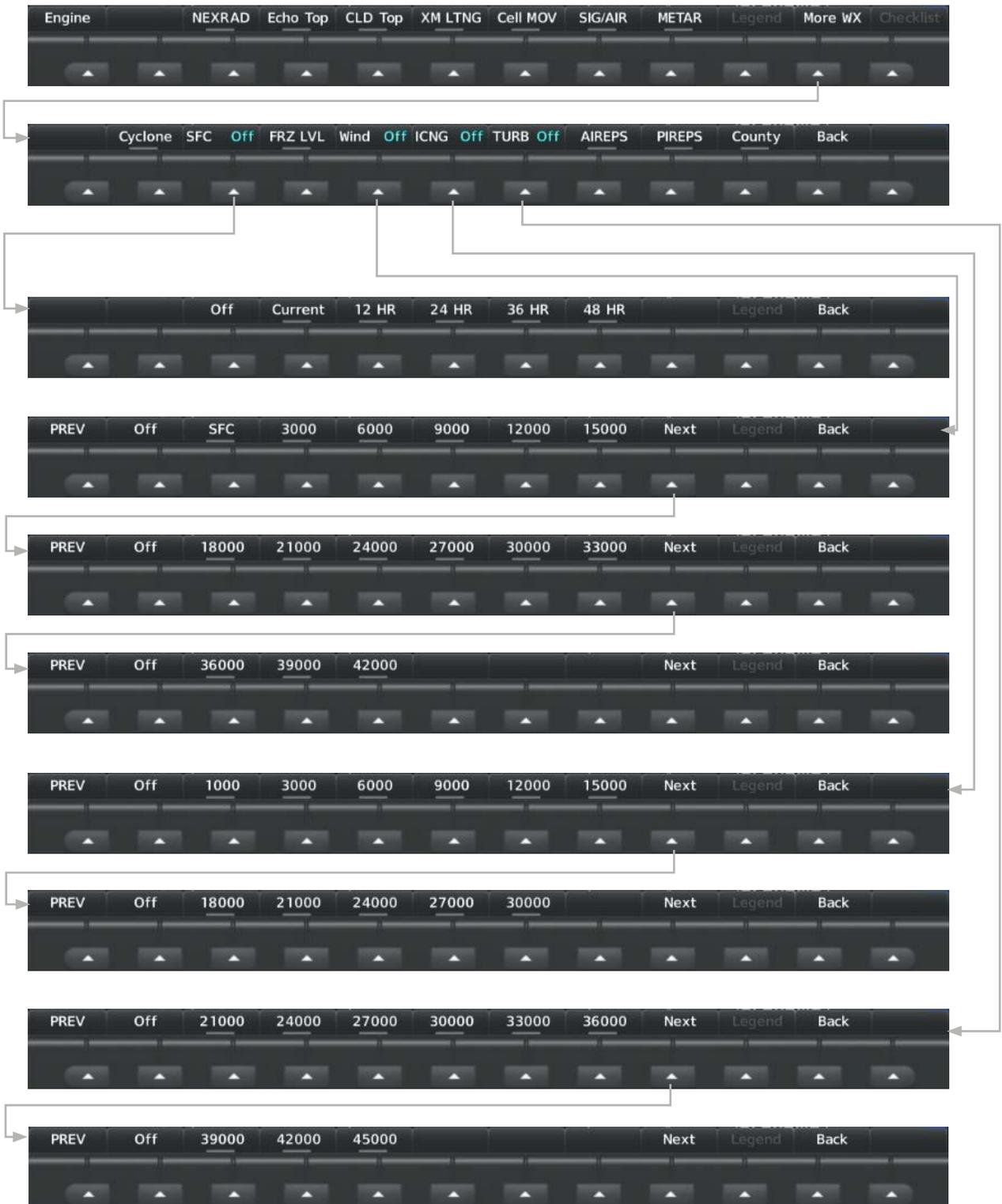


Figure 6-4 Weather Data Link (XM) Page Weather Product Softkeys

- SYSTEM OVERVIEW
- FLIGHT INSTRUMENTS
- EIS
- AUDIO PANEL & CNS
- FLIGHT MANAGEMENT
- HAZARD AVOIDANCE
- AFCS
- ADDITIONAL FEATURES
- APPENDICES
- INDEX

WEATHER DATA LINK (FIS-B) PAGE SOFTKEYS



Figure 6-5 Weather Data Link (FIS-B) Weather Product Softkeys

The Weather Data Link Page can display a legend for each enabled weather product.

Viewing legends for displayed weather products on the Weather Data Link Page:

- 1) Select the Weather Data Link Page.
- 2) Press the **Legend** Softkey to display the legends for the displayed weather products.
Or:
 - a) Press the **MENU** Key.
 - b) Select 'Weather Legend' and press the **ENT** Key.
- 3) Turn the **FMS** Knob to scroll through the legends if more are available than fit in the window.
- 4) To remove the Weather Legends Window, press the **Legend** Softkey, the **ENT** or the **CLR** Key, or press the **FMS** Knob.

Additional information about the following weather products can be displayed by panning the Map Pointer over the following products on the Weather Data Link Page:

- Echo Tops
- Cloud Tops
- Cell Movement
- SIGMETs
- AIRMETs
- METARs
- County Warnings
- TFRs
- AIREPs
- PIREPs

The map panning feature is enabled by pressing the **Joystick**. The map range is adjusted by turning the **Joystick**. If the map range is adjusted while panning is enabled, the map is re-centered on the Map Pointer.



Figure 6-6 Panning on the Weather Data Link (XM) Page

Certain weather products, such as METARs or TFRs have associated full text. When a weather product is selected with the Map Pointer, press the **ENT** Key. The system displays the full text for the selected weather product in a window. To remove the window, press the **FMS** Knob or the **CLR** Key.

The Weather Data Link Page also has a page menu that can be accessed by pressing the **MENU** Key. It has controls for enabling/disabling the weather products as an alternative to using the softkeys.

CUSTOMIZING THE WEATHER DATA LINK PAGE

The Weather Data Link Page includes controls for selecting the maximum map range to display each weather product on the page. If the pilot increases the map range beyond this selected maximum range, the system removes the weather product from the map. If more than one data link weather source has been

installed, the system uses the same maximum map range for the comparable weather product of another source.

Setting up and customizing the Weather Data Link Page:

- 1) Select the Weather Data Link Page.
- 2) Press the **MENU** Key.
- 3) Turn the **FMS** Knob to highlight 'Weather Setup', then press the **ENT** Key.
- 4) Turn the small **FMS** Knob to select 'Product Group 1' or 'Product Group 2', and press the **ENT** Key.



NOTE: 'Product Group 2' is not applicable to FIS-B Weather.

- 5) Turn the large **FMS** Knob or press the **ENT** Key to scroll through product selections.
- 6) Turn the small **FMS** Knob to scroll through options for each product (ON/OFF, range settings, etc.).
- 7) Press the **ENT** Key to select an option.
- 8) Press the **FMS** Knob or **CLR** Key to return to the Weather Data Link (XM) Page with the changed settings.

Restoring default Weather Data Link Page settings:

- 1) Select the Weather Data Link Page.
- 2) Press the **MENU** Key.
- 3) Turn the **FMS** Knob to highlight 'Weather Setup', then press the **ENT** Key.
- 4) Press the **MENU** Key.
- 5) Highlight the desired default(s) to restore (all or for selection) and press **ENT** Key.
- 6) When finished, press the **FMS** Knob or press the **CLR** Key.

WEATHER PRODUCT MAP OVERLAYS

Other PFD and MFD maps and pages can display a smaller set of data link weather products. The following table shows which data link weather products can be displayed on specific maps, indicated with a '+' symbol.

Data Link Weather Product	PFD Map	Navigation Map Page	Weather Data Link Page	Weather Information Page	Aux - Trip Planning Page	Aux - Video Page	Nearest Page Group	Flight Plan Pages
NEXRAD	+	+	+		+	+	+	+
Cloud Top			+					
Echo Top			+					
Data Link Lightning	+	+	+		+	+	+	+
Cell Movement		+	+		+			
SIGMETs/AIRMETs			+					
METARs	+	+	+	+	+	+	+	+
Surface Analysis & City Forecast			+					
Freezing Levels			+					
Winds Aloft		+*	+					
County Warnings			+					
Cyclone Warnings			+					
Icing Potential			+					
PIREPs			+	+				
AIREPs			+	+				
Turbulence (TURB)			+					
No Radar Coverage	+	+	+		+	+	+	+
TFRs	+	+	+	+	+	+	+	+
TAFs				+				

* Winds Aloft data is available inside the VSD when VSD is enabled on the Navigation Map Page.

Table 6-3 Weather Product Display Maps

Displaying Data Link Weather Products on the Navigation Map Page:

- 1) Select the Navigation Map Page.
- 2) Press the **Map Opt** Softkey.
- 3) Press the softkey to enable/disable the desired weather product.

The Navigation Map Page also can display legends for weather products enabled on this map with the **Legend** Softkey. This softkey is subdued if no weather products are enabled.

Showing/removing the weather legend on the Navigation Map Page:

- 1) Select the Navigation Map Page.
- 2) Press the **Map Opt** Softkey.
- 3) Press the **Legend** Softkey to show the weather legends window.
- 4) When finished, press the **Legend** Softkey again, or press the **FMS** Knob or the **CLR** Key to remove the window.

The Navigation Map Page also allows the pilot to select the maximum map range to display weather products. If the pilot increases the map range beyond this selected maximum range, the system removes the weather product from the map. The system uses this setting for all navigation maps, including those displayed on the PFD.

Setting up and customizing weather data for the navigation maps:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) With 'Map Settings' highlighted, press the **ENT** Key.
- 4) Turn the small **FMS** Knob to select the 'Weather' Group and press the **ENT** Key.
- 5) Turn the large **FMS** Knob or press the **ENT** Key to scroll through product selections.
- 6) Turn the small **FMS** Knob to scroll through options for each product (ON/OFF, range settings).
- 7) Press the **ENT** Key to select an option.
- 8) Press the **FMS** Knob or **CLR** Key to return to the Navigation Map Page with the changed settings.

The system can also display data link weather information on the PFD navigation maps.

Displaying Data Link Weather products on the PFD:

- 1) On the PFD, press the **Map/HSI** Softkey.
- 2) Press the desired weather product softkey(s) to enable/disable the display of data link products on the PFD map.

On the MFD maps, the weather product icon and age appear automatically when a weather is enabled and the range is within the maximum display limits. On PFD maps, this information is available using the PFD softkeys.

Enabling/disabling the weather product icon and age display (PFD maps):

- 1) On the PFD, press the **Map/HSI** Softkey.
- 2) Press the **Layout** Softkey.
- 3) Press the **WX LGND** Softkey to enable/disable the weather product age, source, and icon box display on PFD Maps.

The setup menus for the Navigation Map Page and the Weather Data Link Page control the map range settings above which weather products data are decluttered from the display. If a map range larger than the weather product map range setting is selected, the weather product data is removed from the map. The page menus also provide an alternative to using the softkeys to enable/disable data link weather product overlays on maps.

For radar sites in the United States, the NEXRAD weather product shows a composite reflectivity image. This shows the *highest* radar energy received from multiple antenna tilt angles at various altitudes. For radar sites based in Canada, the NEXRAD weather product shows radar returns from the lowest antenna tilt angle, known as base reflectivity. The display of the information is color-coded to indicate the intensity of the echoes and the type of precipitation, if known.

Displaying the NEXRAD weather product on the Weather Data Link (XM) Page:

- 1) Select the Weather Data Link (XM) Page.
- 2) Press the **NEXRAD** Softkey.

A mosaic of data from all the available NEXRAD radar sites is shown.

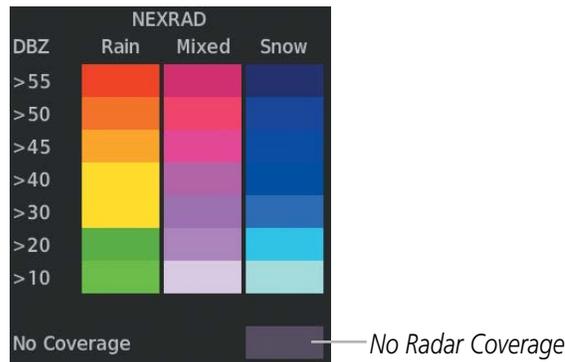


Figure 6-8 NEXRAD Weather Product Legend

Displaying the NEXRAD weather product on the Navigation Map Page:

- 1) Press the **Map Opt** Softkey.
- 2) Press the **NEXRAD** Softkey.

Displaying the NEXRAD weather product on PFD maps:

- 1) Press the **Map/HSI** Softkey.
- 2) Press the **NEXRAD** Softkey to enable/disable the display of NEXRAD information.

The display of No Radar Coverage is always active when either NEXRAD or Echo Tops is selected. Areas where NEXRAD radar coverage and Echo Tops information is not currently available or is not being collected are indicated in gray shade of purple.

The pilot can select either the United States or Canada region for the desired NEXRAD coverage area on the Weather Data Link (XM) Page. NEXRAD information is shown for the selected region, while a gray shade of purple is shown for the region which is not selected.

Selecting the NEXRAD Coverage Region on the Weather Data Link (XM) Page:

- 1) Press the **MENU** Key.
- 2) Turn the **FMS** Knob to select 'Weather Setup' and press the **ENT** Key.
- 3) With Product Group 1 selected, turn the large **FMS** Knob to highlight the NEXRAD Region field.

SYSTEM OVERVIEW

FLIGHT INSTRUMENTS

EIS

AUDIO PANEL & CNS

FLIGHT MANAGEMENT

HAZARD AVOIDANCE

AFCS

ADDITIONAL FEATURES

APPENDICES

INDEX

- 4) Turn the small FMS Knob to select 'US' or 'CNDA', then press the **ENT** Key.
- 5) To remove the menu, push the **FMS** Knob or the **CLR** Key.

The NEXRAD weather product age display indicates either 'US' or 'CN' for the selected coverage region.

REFLECTIVITY

Reflectivity is the amount of transmitted power returned to the radar receiver. Colors on the NEXRAD display are directly correlative to the level of detected reflectivity. Reflectivity as it relates to hazardous weather can be very complex.

The role of radar is essentially to detect moisture in the atmosphere. Simply put, certain types of weather reflect radar better than others. The intensity of a radar reflection is not necessarily an indication of the weather hazard level. For instance, wet hail returns a strong radar reflection, while dry hail does not. Both wet and dry hail can be extremely hazardous.

The different NEXRAD echo intensities are measured in decibels (dB) relative to reflectivity (Z). NEXRAD measures the radar reflectivity ratio, or the energy reflected *back to* the radar receiver (designated by the letter Z). The value of Z increases as the returned signal strength increases.

NEXRAD LIMITATIONS

NEXRAD radar images may have certain limitations:

- Undetermined precipitation types may be displayed as mixed.
- An individual NEXRAD site cannot depict high altitude storms at close ranges. It has no information about storms directly over the site.
- Precipitation may be occurring below the lowest antenna tilt angle (0.5°), and therefore the radar beam overshoots the precipitation. For example, at a distance of 124 miles from the radar site, the radar beam is approximately 18,000 feet above the radar site. The radar cannot detect any precipitation occurring below the beam at this distance and altitude.
- At smaller map ranges, the smallest square block on the display represents an area of approximately four square kilometers. The intensity level reflected by each square represents the highest level of radar reflectivity sampled within the area.
- Unknown precipitation below 52°N is displayed as rain regardless of actual precipitation type.

Block represents approximately 4 km²



Figure 6-9 NEXRAD Weather Product with 30 NM Map Range

The following may cause abnormalities in displayed NEXRAD radar images:

- Ground clutter
- Strokes and spurious radar data
- Sun strokes (when the radar antenna points directly at the sun)
- Interference from buildings or mountains, which may cause shadows
- Metallic dust (chaff) from military aircraft, which can cause alterations in radar scans

NEXRAD LIMITATIONS (CANADA)

- Radar coverage extends to 55°N.
- Any precipitation displayed between 52°N and 55°N is displayed as mixed precipitation regardless of actual precipitation type.
- If the precipitation type is unknown, the system displays the precipitation as rain, regardless of actual precipitation type.



Figure 6-10 NEXRAD Weather Product - Canada

NEXRAD (FIS-B)



NOTE: The NEXRAD weather product cannot be displayed at the same time as relative terrain on the same map.

The National Weather Service (NWS) operates the WSR-88D, or NEXRAD (NEXt-generation RADar) system, an extensive network of 156 high-resolution Doppler radar systems. The NEXRAD network provides centralized meteorological information for the continental United States and selected overseas locations. The maximum range of a single NEXRAD site is 250 nm.

Individual NEXRAD sites supply the network with radar images, and the images from each radar site may arrive at the network at different rates and times. Periodically, the weather data provider to FIS-B compiles the available individual site images from the network to form a composite image, and assigns a single time to indicate when it created the image. This image becomes the NEXRAD weather product. Individual images--gathered from each NEXRAD site--differ in age, and are always older than the displayed NEXRAD weather product age. The data provider then sends the NEXRAD data to the FIS-B GBTs, which transmit this information during the next designated broadcast time for the NEXRAD weather product.

Because of the time required to detect, assemble, and distribute the NEXRAD weather product, the displayed weather information contained within the product may be older than the current radar synopsis and may not depict the current weather conditions. NEXRAD information should never be used as a basis for maneuvering in, near, or around areas of hazardous weather regardless of the information it contains.



Figure 6-11 Regional NEXRAD Weather Product on the Weather Data Link (FIS-B) Page

The FIS-B NEXRAD weather product may be displayed for a region around the GBT (higher resolution, updated more frequently) or for across the continental United States (lower resolution, updated less frequently). A combined version of both weather products is also available for display on the same map. When the combined NEXRAD is selected, regional NEXRAD takes display precedence where data is available, and continental US NEXRAD is displayed outside of the regional NEXRAD coverage area.

Displaying the NEXRAD weather product on the Weather Data Link (FIS-B) Page:

- 1) Select the Weather Data Link (FIS-B) Page.
 - 2) Select the **NEXRAD** Softkey. Each selection cycles through a coverage option as the softkey name changes (**US**, **RGNL**, or **US/RGNL**).
- Or:**
- 1) Press the **MENU** Key.
 - 2) Turn the **FMS** Knob to highlight 'Weather Setup' and press the **ENT** Key.
 - 3) To enable/disable the display of NEXRAD information for the continental United States, turn the small **FMS** Knob to highlight the NEXRAD On/Off field.
 - a) Turn the small **FMS** Knob to highlight 'On' to enable the display of NEXRAD for the continental United States or 'Off' to disable.
 - b) Press the **ENT** Key.

- SYSTEM OVERVIEW
- FLIGHT INSTRUMENTS
- EIS
- AUDIO PANEL & CNS
- FLIGHT MANAGEMENT
- HAZARD AVOIDANCE
- AFCS
- ADDITIONAL FEATURES
- APPENDICES
- INDEX

- 4) To enable/disable the display of Regional NEXRAD information, turn the small **FMS** Knob to highlight the Regional On/Off field.
 - a) Turn the small **FMS** Knob to highlight 'On' to enable the display of Regional NEXRAD or 'Off' to disable.
 - b) Press the **ENT** Key.
- 5) When finished, push the **FMS** Knob.

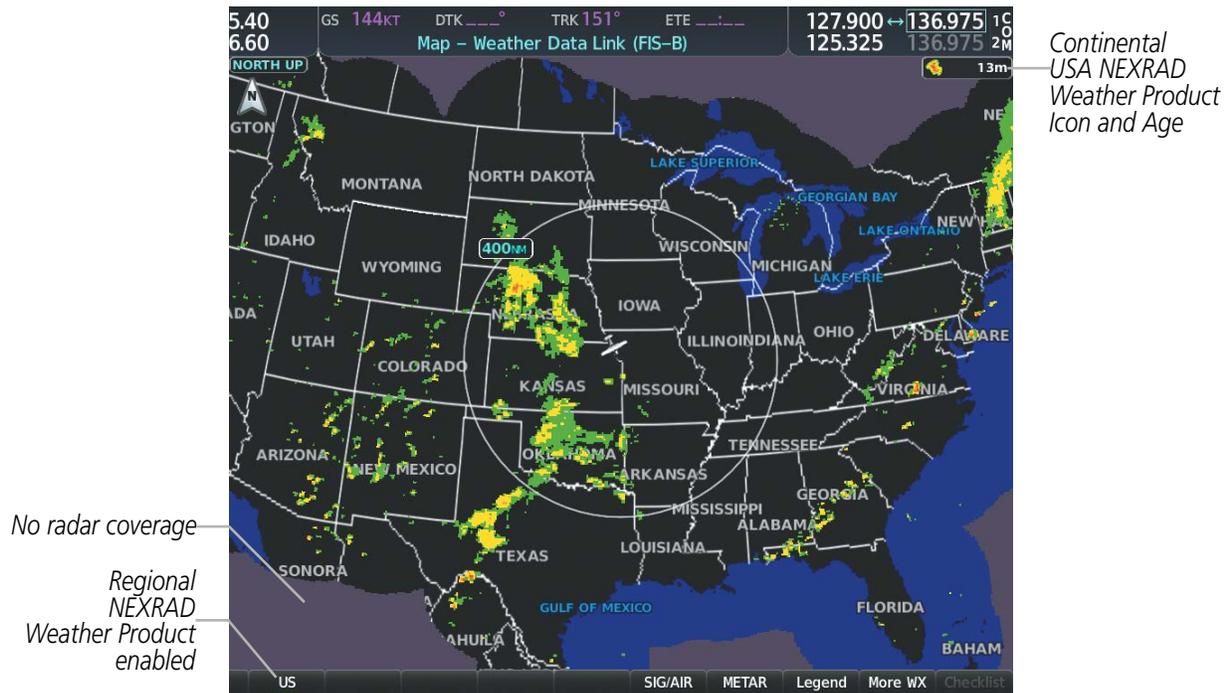


Figure 6-12 Continental US (CONUS) NEXRAD Weather Product on the Weather Data Link (FIS-B) Page



NOTE: When both NEXRAD options are enabled on the Weather Data Link (FIS-B) Page menu, a combined version is displayed.

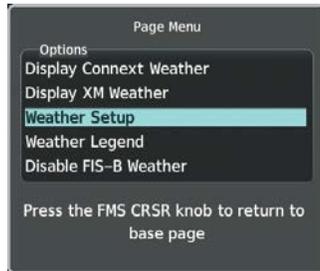


Figure 6-13 Weather Data Link (FIS-B) Page Menu

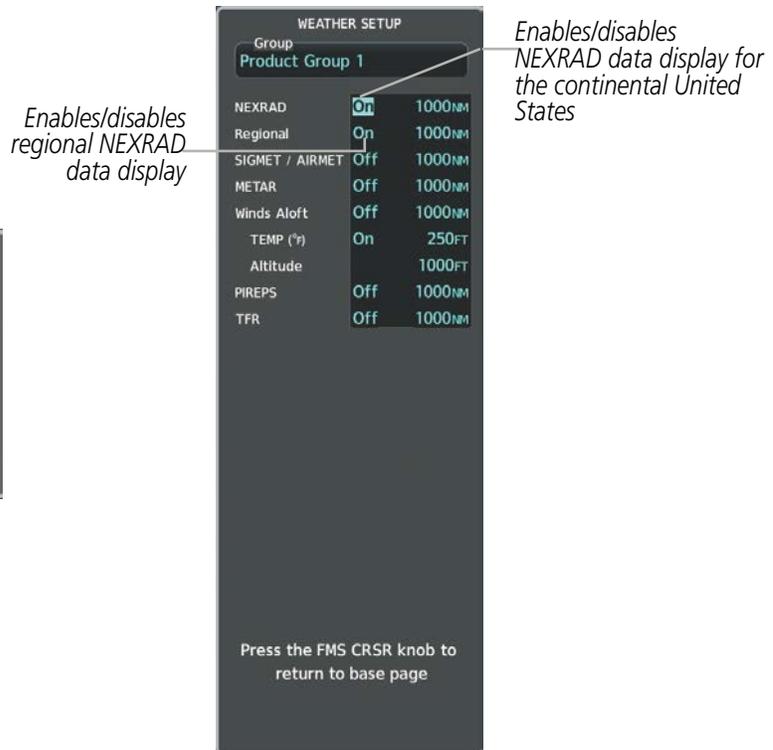


Figure 6-14 Weather Data Link (FIS-B) Page Setup Menu

Displaying the NEXRAD weather product on the Navigation Map Page:

- 1) Select the **Map Opt** Softkey.
- 2) Select the **NEXRAD** Softkey.
- 3) To change the type of NEXRAD displayed, press the **MENU** Key.
- 4) With 'Map Settings' highlighted, press the ENT Key.
- 5) Turn the small **FMS** Knob to select the 'Weather' Group, then press the **ENT** Key.
- 6) Turn the large **FMS** Knob to highlight the NEXRAD Data Region field.
- 7) Turn the small **FMS** Knob to highlight 'CONUS' (continental United States), 'RGNL' (regional), or 'Combined', then press the **ENT** Key. This selection also affects display of NEXRAD on the PFD Maps.
- 8) When finished, press the **FMS** Knob or press the **CLR** Key.

Displaying the NEXRAD weather product on PFD maps:

- 1) Press the **Map/HSI** Softkey (in TCAS II installations, press the **Map Opt** Softkey).
- 2) Press the **NEXRAD** Softkey to enable/disable the display of NEXRAD information.

The regional NEXRAD weather product coverage area varies, as it is determined by the data received from ground-based sources. When the regional NEXRAD weather product is enabled, a white spiked boundary encloses this area to indicate the geographic limits of the regional NEXRAD coverage being displayed. The system shows composite radar data from all available NEXRAD sites inside of this boundary area.

If the continental United States version of the NEXRAD weather product is shown (**US** Softkey enabled), the coverage boundary is not shown on the map.

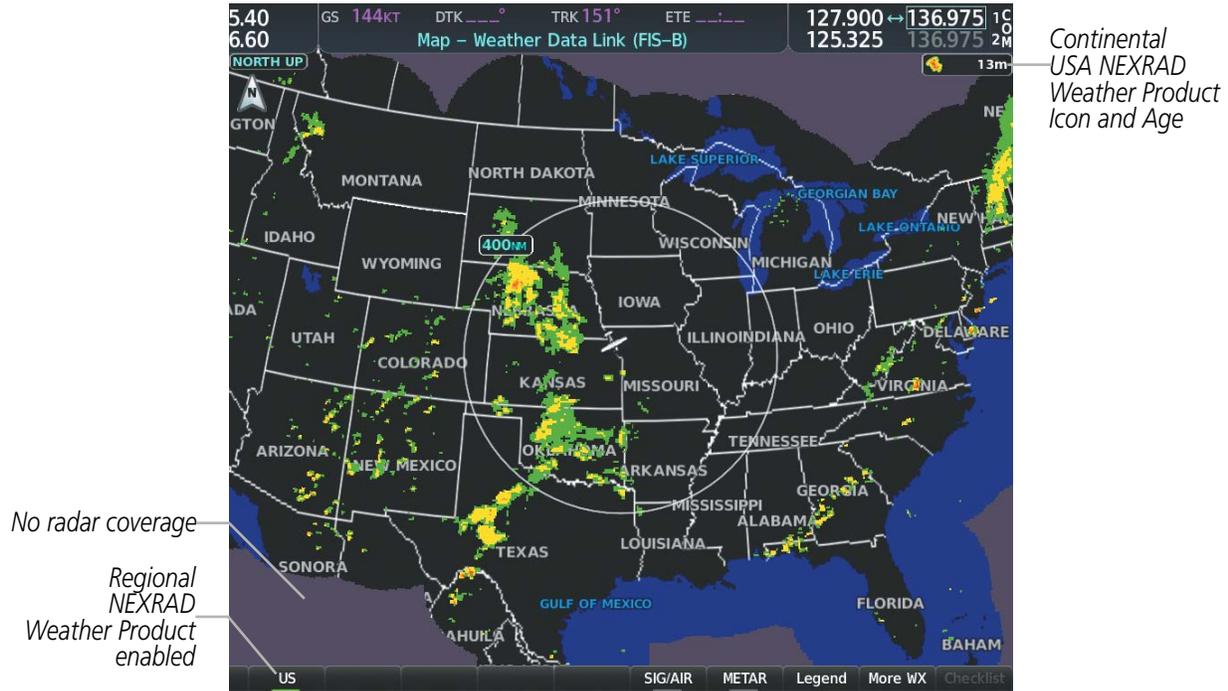


Figure 6-15 Continental US (CONUS) NEXRAD Weather Product on the Weather Data Link (FIS-B) Page

This data is composed of the maximum reflectivity from the individual radar sweeps. The display of the information is color-coded to indicate the weather severity level. All weather product legends can be viewed on the Weather Data Link (FIS-B) Page. For the NEXRAD legend, select the **Legend** Softkey when the NEXRAD weather product is enabled.

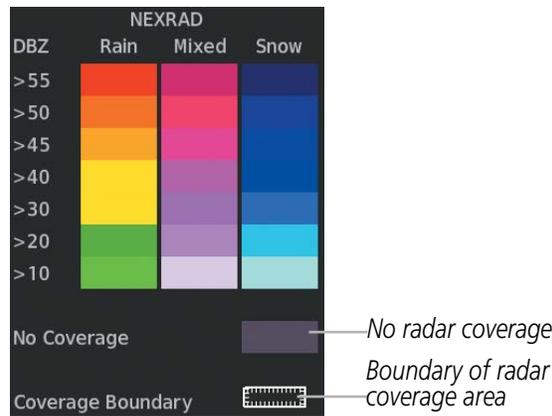


Figure 6-16 NEXRAD Weather Product Legend

The display of no radar coverage is enabled when NEXRAD is selected for display. Areas where radar data is not currently available, has not yet been received, or is not being collected are indicated in gray shade of purple.



NOTE: *If the system has not received all available NEXRAD weather data (such as during initial FIS-B signal acquisition or in areas of marginal or poor signal reception), the system may display areas of no radar coverage which are subsequently removed as radar data is received. It may take up to approximately ten minutes to receive all FIS-B data, when adequate reception is available.*

REFLECTIVITY

Reflectivity is the amount of transmitted power returned to the radar receiver. Colors on the NEXRAD display are directly correlative to the level of detected reflectivity. Reflectivity as it relates to hazardous weather can be very complex.

The role of radar is essentially to detect moisture in the atmosphere. Simply put, certain types of weather reflect radar better than others. The intensity of a radar reflection is not necessarily an indication of the weather hazard level. For instance, wet hail returns a strong radar reflection, while dry hail does not. Both wet and dry hail can be extremely hazardous.

The different NEXRAD echo intensities are measured in decibels (dB) relative to reflectivity (Z). NEXRAD measures the radar reflectivity ratio, or the energy reflected *back to* the radar receiver (designated by the letter Z). The value of Z increases as the returned signal strength increases.

NEXRAD LIMITATIONS

NEXRAD radar images may have certain limitations:

- At smaller map ranges, individual blocks of NEXRAD weather data are viewable. For the regional version of the NEXRAD weather product, the smallest block represents 1.5 nm wide by 1 nm tall. For the continental United States version of the NEXRAD weather product, each block is 7.5 nm wide by 5 nm wide. The color of each block represents the *highest* radar reflectivity detected within that area.
- The continental US version of the NEXRAD weather product is not available above 60° of latitude.

The following may cause abnormalities in displayed NEXRAD radar images:

- Ground clutter
- Strokes and spurious radar data
- Sun strokes (when the radar antenna points directly at the sun)
- Interference from buildings or mountains, which may cause shadows
- Metallic dust (chaff) from military aircraft, which can cause alterations in radar scans

ECHO TOPS (SIRISUXM)



NOTE: Echo Tops cannot be displayed at the same time as Cloud Tops or NEXRAD data is displayed.

The Echo Tops weather product shows the location, elevation, and direction of the highest radar echo. The highest radar echo does not indicate the top of a storm or clouds; rather it indicates the highest altitude at which precipitation is detected. Information is derived from NEXRAD data.



Figure 6-17 Echo Tops Weather Product

Displaying Echo Tops information:

- 1) Select the Weather Data Link (XM) Page.
- 2) Press the **Echo Top** Softkey.

Since Echo Tops and Cloud Tops use the same color scaling to represent altitude, display of these weather products is mutually exclusive. When Echo Tops is activated, NEXRAD and Cloud Tops data are removed.

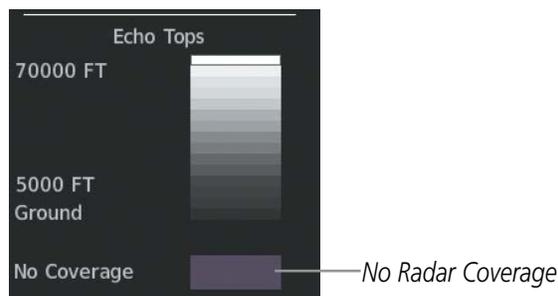


Figure 6-18 Echo Tops Legend

CLD TOPS (SIRIUSXM)



NOTE: Cloud Tops and Echo Tops cannot be displayed at the same time.



NOTE: If a GDL 69/69A SXM receiver is installed, the broadcast rate for Cloud Tops is 30 minutes. As with all SiriusXM Weather products, the product age becomes amber when it reaches half of the expiration time, which is 60 minutes for Cloud Tops. Therefore, this weather product age may be amber during routine operation.

The Cloud Tops weather product depicts cloud top altitudes as determined from satellite imagery.

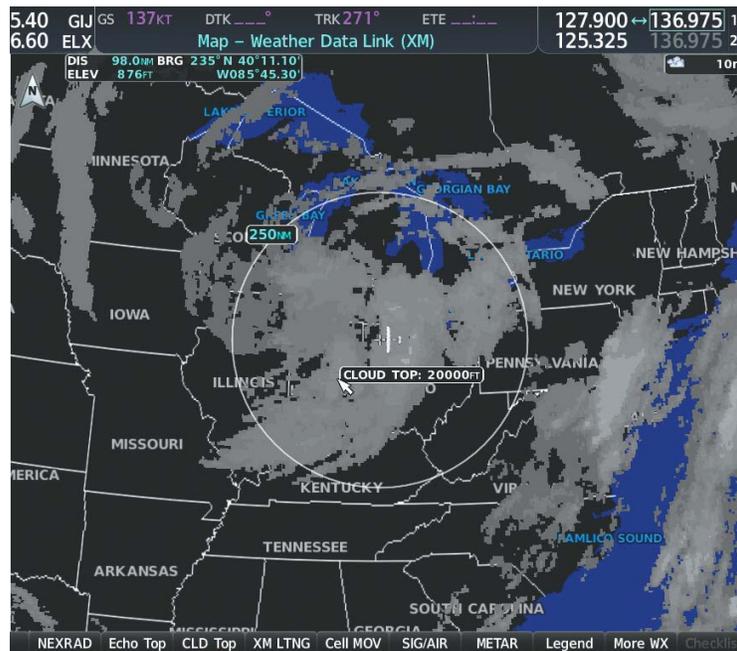


Figure 6-19 Cloud Tops Weather Product

Displaying Cloud Tops information:

- 1) Select the Weather Data Link (XM) Page with the **FMS** Knob.
- 2) Select the **CLD Top** Softkey.

Since Cloud Tops and Echo Tops use the same color scaling to represent altitude, display of these weather products is mutually exclusive. When Cloud Tops is activated, Echo Tops data is removed.

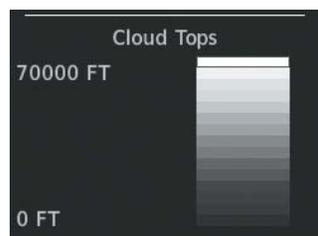


Figure 6-20 Cloud Tops Legend

DATA LINK LIGHTNING



NOTE: Lightning from a data link source cannot be displayed simultaneously on the same map as information from an optional on-board lightning detection system.

The Data Link Light weather product shows the approximate location of cloud-to-ground lightning strikes. A strike icon represents a strike that has occurred within a two-kilometer region. The exact location of the lightning strike is not displayed.

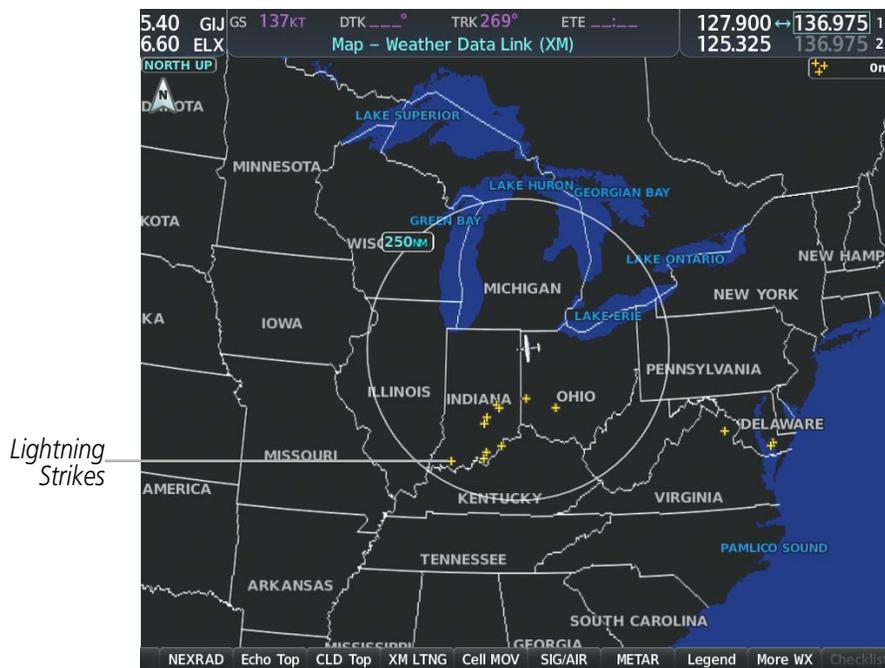


Figure 6-21 Data Link Weather Product

Displaying Data Link Lightning information on Weather Data Link Page:

- 1) Turn the **FMS** Knob to select the Weather Data Link Page.
- 2) Press the **XM LTNG** or **DL LTNG** Softkey (softkey name depends on the selected weather source).

To display the Lightning legend on the Weather Data Link Page, select the **Legend** Softkey when Data Link Lightning is selected for display.

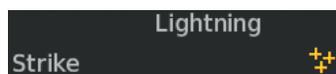


Figure 6-22 Data Link Lightning Legend

Displaying Data Link Lightning information on the Navigation Map Page:

- 1) Turn the **FMS** Knob to select the Navigation Map Page.
- 2) Select the **Map Opt** Softkey.
- 3) Select the **XM LTNG** or **DL LTNG** Softkey.

Enabling/disabling Data Link Lightning information on PFD maps:

- 1) On the PFD, press the **Map/HSI** Softkey.
- 2) Press the **Lightning** Softkey.
- 3) Press the **Datalink** Softkey to enable data link lightning from the selected data link weather source, or press the **LTNG Off** Softkey to disable data link lightning.
- 4) When finished, press the **Back** Softkey.

CELL MOVEMENT (SIRIUSXM)

The Cell Movement weather product shows the location and movement of storm cells as identified by the ground-based system. Cells are represented by yellow squares, with direction of movement indicated with short, orange arrows.



Figure 6-23 Cell Movement Weather Product

On the Weather Data Link (XM) Page, the Cell Movement weather product has a dedicated **CEL MOV** softkey for enabling/disabling this weather product on this page.



NOTE: The Storm Cell base height is not available if a GDL 69 SXM or 69A SXM data link receiver is installed. In this case, the Storm Cell base height is displayed as 0 feet when the map pointer selects a storm cell.

Displaying Cell Movement information on the Weather Data Link (XM) Page:

- 1) Select the Weather Data Link (XM) Page using the **FMS** Knob.
- 2) Select the **Cell MOV** Softkey.

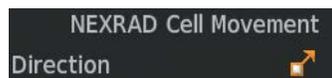


Figure 6-24 Cell Movement Legend

For navigation maps, the pilot can enable/disable the Cell Movement weather product using the **NEXRAD** Softkey. For this to occur, the pilot must first enable the 'Cell Movement' option in the Map Settings menu of the Navigation Map Page.

Setting up the system to display Cell Movement with NEXRAD on navigation maps:

- 1) Use the **FMS** Knob to select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) With 'Map Settings' highlighted, press the **ENT** Key.
- 4) Turn the small **FMS** Knob to highlight 'Weather' and press the **ENT** Key.
- 5) Turn the large **FMS** Knob to 'On' or 'Off' for the Cell Movement menu option. When set to 'On', Cell Movement is enabled/disabled with the NEXRAD weather product on navigation maps. When set to 'Off', Cell Movement is not displayed on navigation maps.
- 6) When finished, push the **FMS** Knob or **CLR** Key to remove the menu.

After the 'Cell Movement' option is set to 'On', refer to the previous procedures for enabling/disabling the NEXRAD weather product to control both products simultaneously on navigation maps using the **NEXRAD** Softkey.

SIGMETS AND AIRMETS

SIGMET (SIGnificant METeorological Information) and AIRMET (AIRmen's METeorological Information) are issued for potentially hazardous weather. A Convective SIGMET is issued for hazardous convective weather such as severe or widespread thunderstorms. A localized SIGMET is a significant weather condition occurring at a localized geographical position.



NOTE: If SiriusXM Weather is the active data link weather source and a GDL 69/69A SXM receiver installed, the SIGMET and AIRMET weather products are not available unless at least one SIGMET or AIRMET has been received. The weather product age indicates 'N/A' when no SIGMET or AIRMET is available.

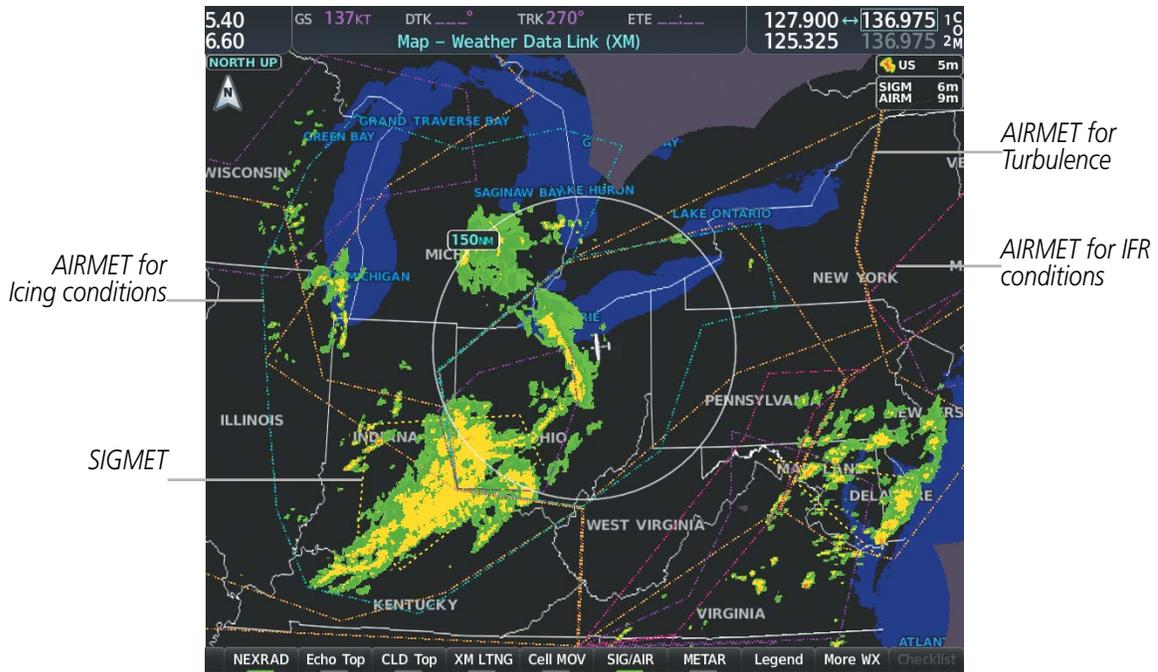
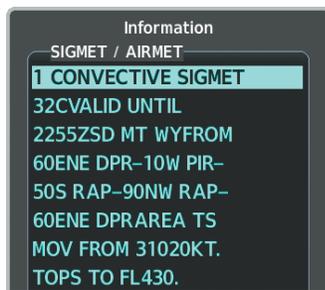


Figure 6-25 SIGMET/AIRMET Data

Displaying SIGMETs and AIRMETs:

- 1) Select the Weather Data Link Page.
- 2) Press the **SIG/AIR** Softkey.
- 3) To view the text of the SIGMET or AIRMET, press the **Joystick** and move the Map Pointer over the icon.
- 4) Press the **ENT** key. The following figure shows sample SIGMET text.



Sample SIGMET Text



SIGMET/AIRMET Legend

Figure 6-26 SIGMET/AIRMET Text and Legend

METARS AND TAFS



NOTE: Atmospheric pressure as reported for METARs is given in hectopascals (hPa), except for in the United States, where it is reported in inches of mercury (in Hg). Temperatures are reported in Celsius.



NOTE: METAR information is only displayed within the installed navigation database service area.

METARs (METeorological Aerodrome Reports) typically contain information about the temperature, dewpoint, wind, precipitation, cloud cover, cloud heights, visibility, and barometric pressure at an airport or observation station. They can also contain information on precipitation amounts, lightning, and other critical data. METARs reflect hourly observations; non-routine updates include the code “SPECI” in the report. METARs are shown as colored flags at airports that provide them.

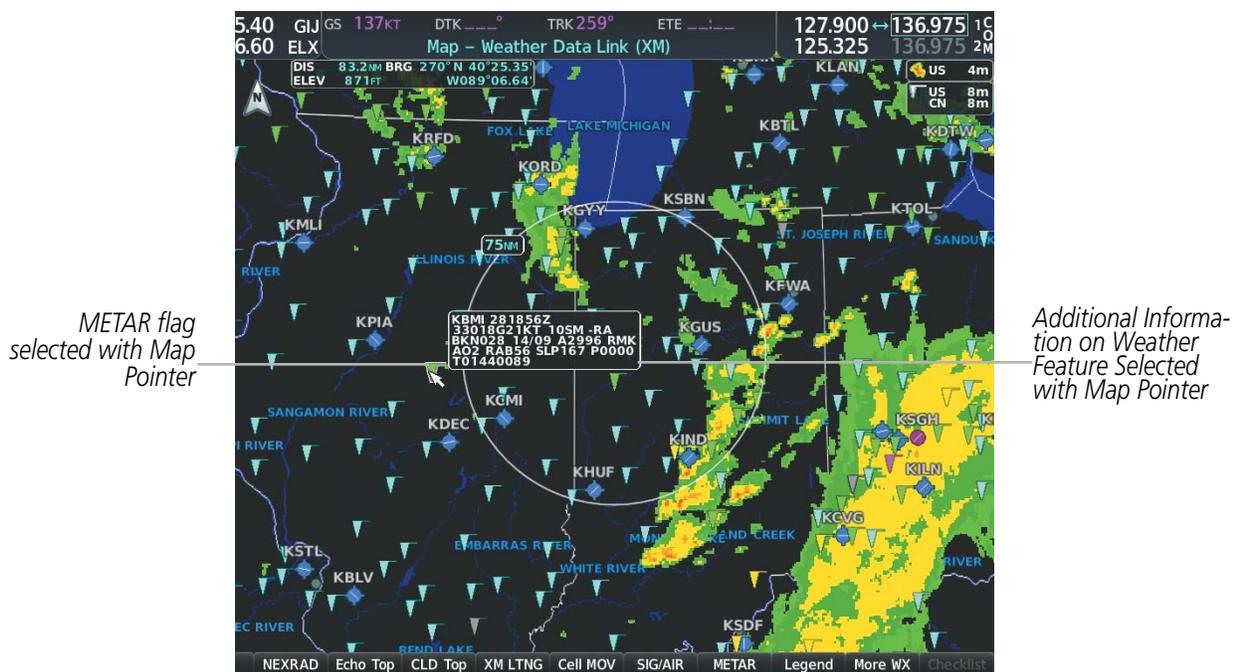


Figure 6-27 METAR Flags on the Weather Data Link Page

TAFs (Terminal Aerodrome Forecasts) are weather predictions for specific airports within a 24- hour period, and may span up to 36 hours. TAFs typically include forecast wind, visibility, weather phenomena, and sky conditions using METAR codes.

METAR and TAF text are displayed on the Weather Information Page. METAR data is displayed first in a decoded fashion, followed by the original text. Note the original text may contain additional information not found in the decoded version. TAF information is displayed only in its original form when TAFs are available.

Displaying METAR and TAF text on the MFD:

- 1) On the Weather Data Link Page, press the **METAR** Softkey.
- 2) Press the **Joystick** and pan to the desired airport.
- 3) Press the **ENT** Key. The Weather Information Page is shown with METAR and TAF text.

- 4) Use the **FMS** Knob or the **ENT** Key to scroll through the METAR and TAF text. METAR text must be completely scrolled through before scrolling through the TAF text.
- 5) Press the **FMS** Knob or the **CLR** Key to return to the Weather Data Link Page.

Or:

- 1) Select the Weather Information Page.
 - a) Turn the large **FMS** Knob to select the Waypoint Page Group.
 - b) Select the **WX** Softkey to select the Weather Information Page.
- 2) Press the **FMS** Knob to display the cursor.
- 3) Use the **FMS** Knob to enter the desired airport and press the **ENT** Key.
- 4) Use the **FMS** Knob or the **ENT** Key to scroll through the METAR and TAF text. Note that the METAR text must be completely scrolled through before scrolling through the TAF text.



Figure 6-28 METAR and TAF Text on the Weather Information Page

To display the METAR legend on the Weather Data Link (XM) Page, select the **Legend** Softkey when METARs are enabled for display.

The METAR flag color is determined by the information in the METAR text. The system displays a gray METAR flag when the system cannot determine the METAR category based on the information available.

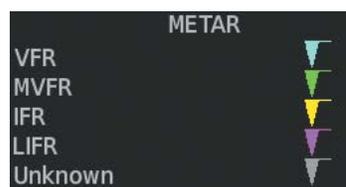


Figure 6-29 METAR Legend

The system also shows METAR flags and their associated text on the Active Flight Plan Page on the MFD. The system shows a METAR flag next to waypoints in the flight plan with an available METAR.

Displaying original METAR text on the Active Flight Plan Page:

- 1) Select the Active Flight Plan Page on the MFD.
- 2) Press the **FMS** Knob to activate the cursor.
- 3) Turn the large **FMS** Knob to highlight a waypoint with an available METAR (indicated with a METAR flag next to it). The METAR text will appear in the 'Selected Waypoint Weather' Window below.
- 4) When finished, press the **FMS** Knob to remove the cursor or press the **FPL** Key to exit the Active Flight Plan Page.

Original METAR text is also accessible on navigation maps displaying METAR flags. When the map pointer is panned over a METAR flag, the METAR text is shown in a box near the flag.

Displaying original METAR text information on the PFD Inset Map:

- 1) On the PFD, press the **Map/HSI** Softkey.
- 2) Press the **METAR** Softkey.
- 3) Press the **Joystick** and pan to the desired METAR flag. Original METAR text appears on the map.
- 4) When finished, press the **Joystick** to remove the Map Pointer.

SURFACE ANALYSIS AND CITY FORECAST (SIRIUSXM)

Surface Analysis and City Forecast information is available for current and forecast weather conditions. Forecasts are available for intervals of 12, 24, 36, and 48 hours.

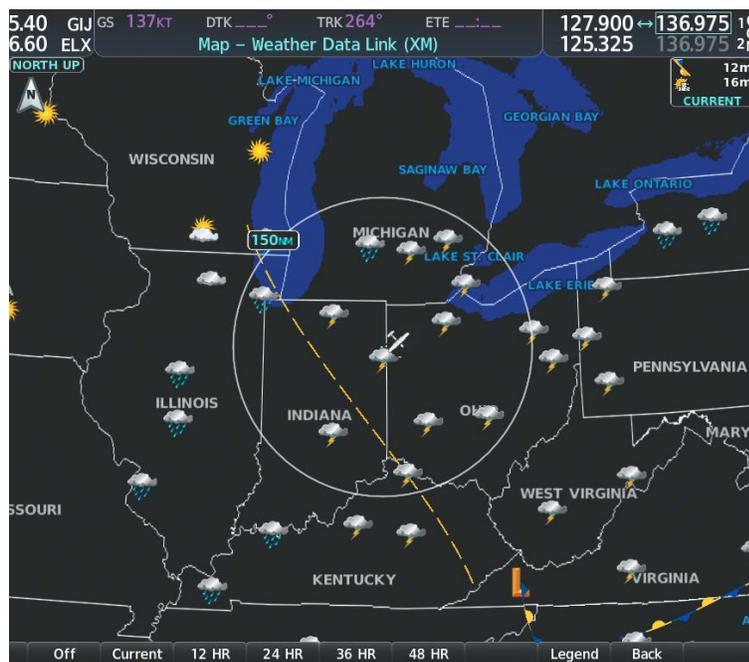


Figure 6-30 Current Surface Analysis Data

Displaying Surface Analysis and City Forecast information:

- 1) Select the Weather Data Link (XM) Page.
- 2) Select the **More WX** Softkey.
- 3) Select the **SFC** Softkey.
- 4) Press the softkey for the desired forecast time: **Current, 12 HR, 24 HR, 36 HR,** or **48 HR.** The **SFC** Softkey label changes to show the forecast time selected.

Or:

Press the **Off** Softkey to disable the display of the weather product.



Figure 6-31 Surface Analysis Legend

FREEZING LEVEL (SIRIUSXM)

The Freezing Level weather product shows the color-coded contour lines for the altitude and location at which the first isotherm is found. When no data is displayed for a given altitude, the data for that altitude has not been received, or is out of date and has been removed from the display. New data appears when it becomes available.



Figure 6-32 Freezing Level Data

Displaying Freezing Level information:

- 1) Select the Weather Data Link (XM) Page.
- 2) Select the **More WX** Softkey.
- 3) Select the **FRZ LVL** Softkey.



Figure 6-33 Freezing Levels Legend

WINDS ALOFT

The Winds Aloft weather product shows the forecast wind speed and direction at the surface and at selected altitudes. Altitude can be displayed in 3000-foot increments beginning at the surface up to 42,000 feet MSL.

If the FIS-B option is installed and FIS-B is the active data link weather source, the Winds Aloft weather product also displays temperatures aloft next to the winds aloft arrows on the Weather Data Link (FIS-B) Page.

Displaying the Winds Aloft weather product:

- 1) Select the Weather Data Link Page with the **FMS** Knob.
- 2) Select the **More WX** Softkey.
- 3) Select the **Wind** Softkey.
- 4) Select a softkey for the desired altitude level: **SFC** (surface) up to 42,000 feet. Select the **Next** or **Prev** Softkey to cycle through the altitude softkeys. The **Wind** Softkey label changes to reflect the altitude selected.

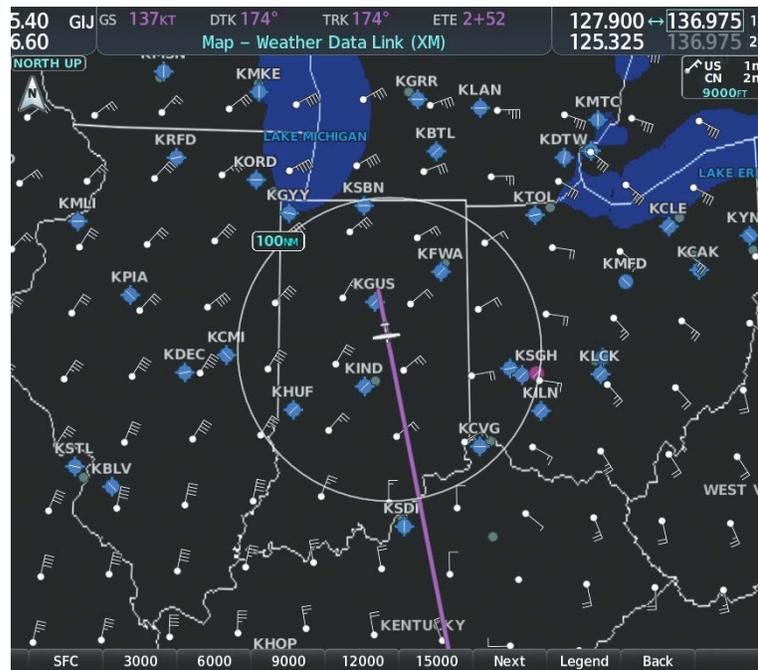


Figure 6-34 Winds Aloft Data at 12,000 Feet



Figure 6-35 Winds Aloft Data with Legend

Headwind and tailwind components aloft are available inside the Vertical Situation Display (VSD) on the Navigation Map Page. The displayed components are relative to current aircraft altitude and track, but not to aircraft speed.



Figure 6-36 Navigation Map Page with Winds Aloft Data on Profile View

Arrows pointing to the left indicate headwind components; tailwind component arrows point to the right, as shown in Table 6-4.

Headwind Symbol	Tailwind Symbol	Headwind/Tailwind Component
None	None	Less than 5 knots
		5 knots
		10 knots
		50 knots

Table 6-4 VSD Headwind/Tailwind Component Symbols

Enabling/disabling the Vertical Situation Display (containing winds aloft data):

- 1) Select the Navigation Map Page.
- 2) Press the **Map Opt** Softkey.
- 3) Press the **Inset** Softkey.
- 4) Press the **VSD** Softkey to enable/disable the Vertical Situation Display.

Or:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) Turn the FMS Knob to highlight 'Show VSD' or 'Hide VSD' and press the **ENT** Key.

Winds Aloft data inside the VSD is enabled by default when the VSD is displayed on the Navigation Map Page. This behavior can be changed on the Navigation Map Page.

Enabling/disabling winds aloft data display for the VSD:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) With 'Map Settings' highlighted, press the **ENT** Key.
- 4) Turn the small **FMS** Knob to select 'VSD' and press the **ENT** Key.
- 5) Turn the large **FMS** Knob to highlight the Winds on/off field.
- 6) Turn the small **FMS** Knob to select 'On' or 'Off'.
- 7) Press the **FMS** Knob or **CLR** Key to return to the Navigation Map Page with the changed settings.

COUNTY WARNINGS (SIRIUSXM)

The County warning weather product provides specific public awareness and protection weather warnings from the National Weather Service (NWS). This can include information on tornadoes, severe thunderstorms, and flood conditions.

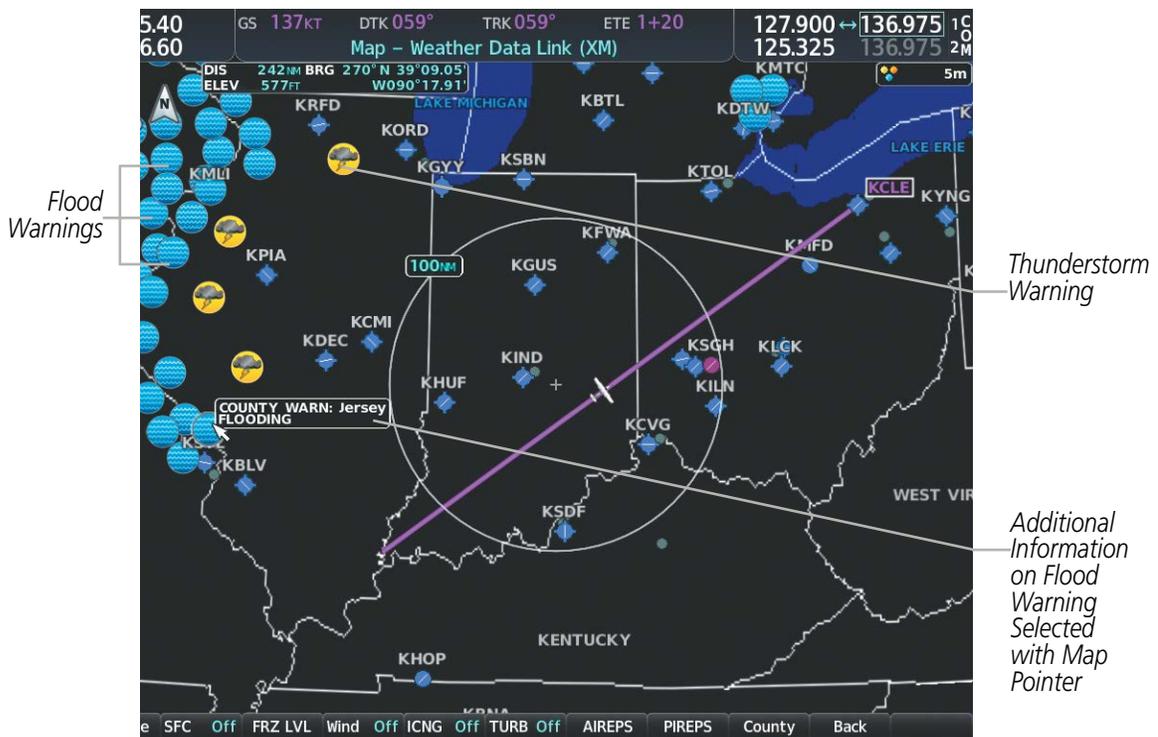


Figure 6-37 County Flood Warning

Displaying County Warning information:

- 1) Select the Weather Data Link (XM) Page with the **FMS** Knob.
- 2) Press the **More WX** Softkey.
- 3) Press the **County** Softkey.

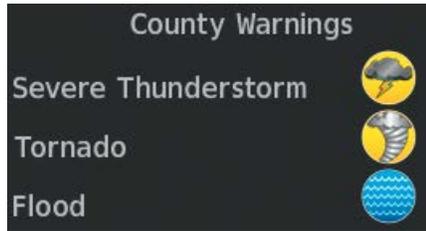


Figure 6-38 County Warnings Legend

CYCLONE (SIRIUSXM)

The Cyclone weather product shows the current location of cyclones (hurricanes), tropical storms, and their projected tracks. The system displays the projected track information in the form of DD/HH:MM.

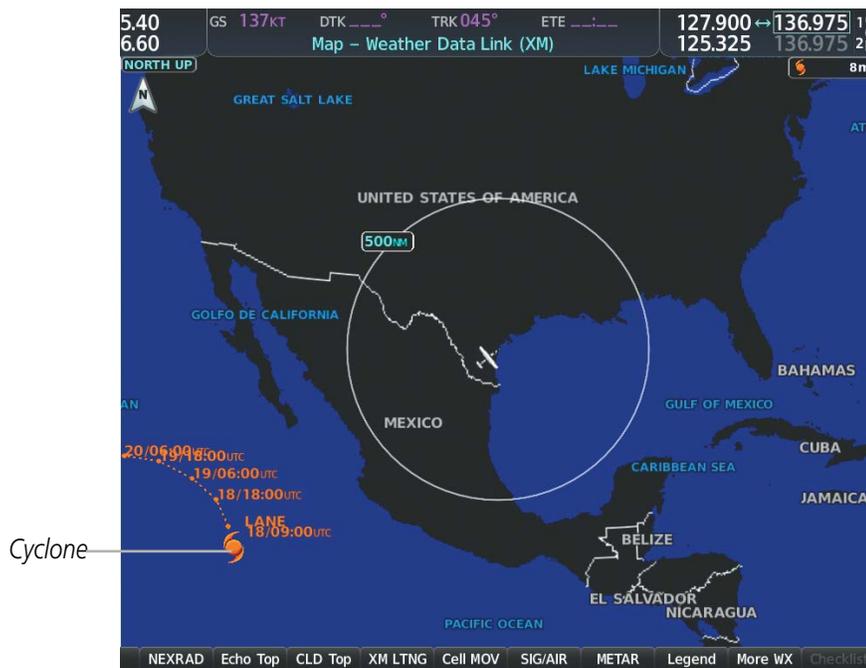


Figure 6-39 Cyclone Weather Product on the Weather Data Link (XM) Page

Displaying cyclone (hurricane) track information:

- 1) Select the Weather Data Link (XM) Page with the **FMS** Knob.
- 2) Select the **More WX** Softkey.
- 3) Select the **Cyclone** Softkey.

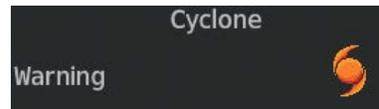


Figure 6-40 Cyclone Legend



NOTE: If a GDL 69/69A SXM receiver is installed, the Cyclone weather product is not available unless at least one cyclone or tropical storm has been received. The weather product age indicates 'N/A' when no cyclone or tropical storm has been received.

ICING (CIP & SLD) (SIRIUSXM)

The Current Icing Product (CIP) weather product shows a graphical view of the current icing environment. Icing severity is displayed in four categories: light, moderate, severe, and extreme (not specific to aircraft type). The CIP product is not a forecast, but a presentation of the current conditions at the time of the analysis.

Supercooled Large Droplet (SLD) icing conditions are characterized by the presence of relatively large, super cooled water droplets indicative of freezing drizzle and freezing rain aloft. SLD threat areas are depicted as magenta dots over the CIP colors.

Displaying Icing data:

- 1) Select the Weather Data Link (XM) Page.
- 2) Select the **More WX** Softkey.
- 3) Select the **ICNG** Softkey.
- 4) Select a softkey for the desired altitude level: 1,000 feet up to 30,000 feet. Select the **Next** or **PREV** Softkey to cycle through the altitude softkeys. The **ICNG** Softkey label changes to indicate the altitude selected.

- SYSTEM OVERVIEW
- FLIGHT INSTRUMENTS
- EIS
- AUDIO PANEL & CNS
- FLIGHT MANAGEMENT
- HAZARD AVOIDANCE
- AFCS
- ADDITIONAL FEATURES
- APPENDICES
- INDEX

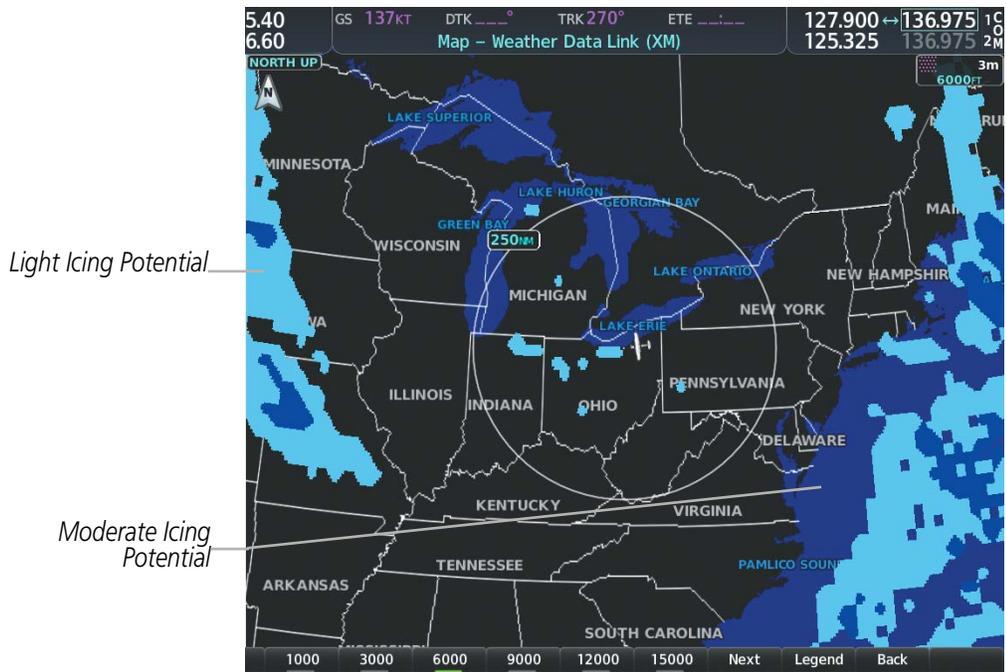


Figure 6-41 Icing Data at 18,000 Feet

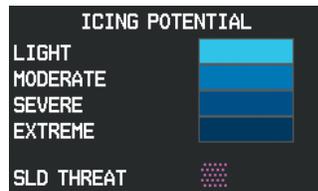


Figure 6-42 Icing Potential Legend

TURBULENCE (SIRIUSXM)

The Turbulence weather product identifies the potential for erratic movement of high-altitude air mass associated winds. Turbulence is classified as light, moderate, severe or extreme, at altitudes between 21,000 and 45,000 feet. Turbulence information is intended to supplement AIRMETs, SIGMETs, and PIREPs.

Displaying Turbulence data:

- 1) Select the Weather Data Link (XM) Page.
- 2) Select the **More WX** Softkey.
- 3) Select the **TURB** Softkey.
- 4) Select a softkey for the desired altitude: 21,000 feet up to 45,000 feet. Press the **Next** or **PREV** Softkey to cycle through the altitude softkeys. The **TURB** Softkey label changes to indicate the altitude selection.

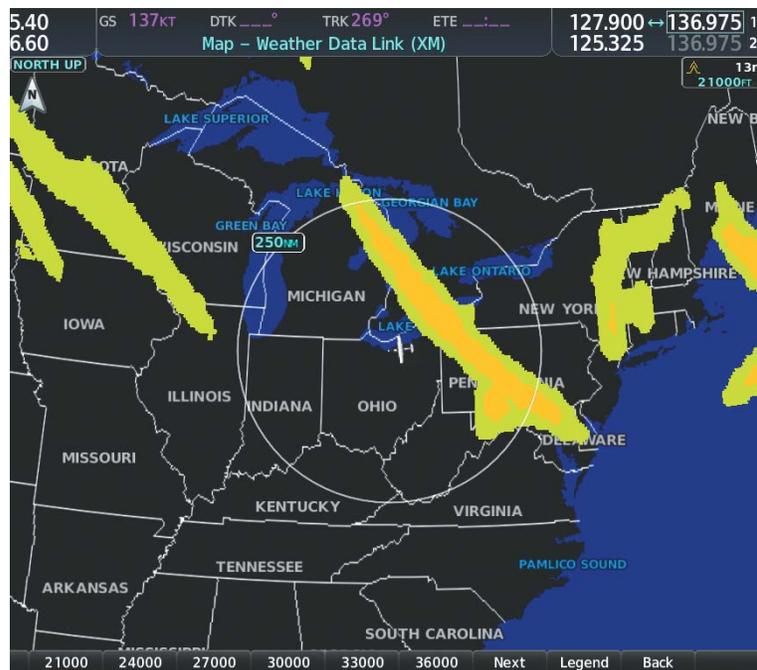


Figure 6-43 Turbulence Weather Product at 21,000 Feet

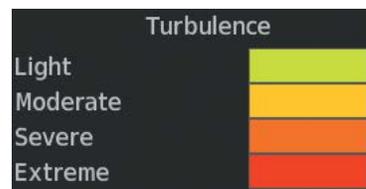


Figure 6-44 Turbulence Legend

PIREPS AND AIREPS



NOTE: AIREPs are only available with the SiriusXM Weather service.

Pilot Weather Reports (PIREPs) are in-flight weather observations collected from pilots. When significant weather conditions are reported or forecast, Air Traffic Control (ATC) facilities are required to solicit PIREPs. A PIREP may contain adverse weather conditions, such as low in-flight visibility, icing conditions, wind shear, and turbulence. PIREPs are issued as either Routine (UA) or Urgent (UUA).

Another type of PIREP is an Air Report (AIREP). Commercial airlines typically generate AIREPs.

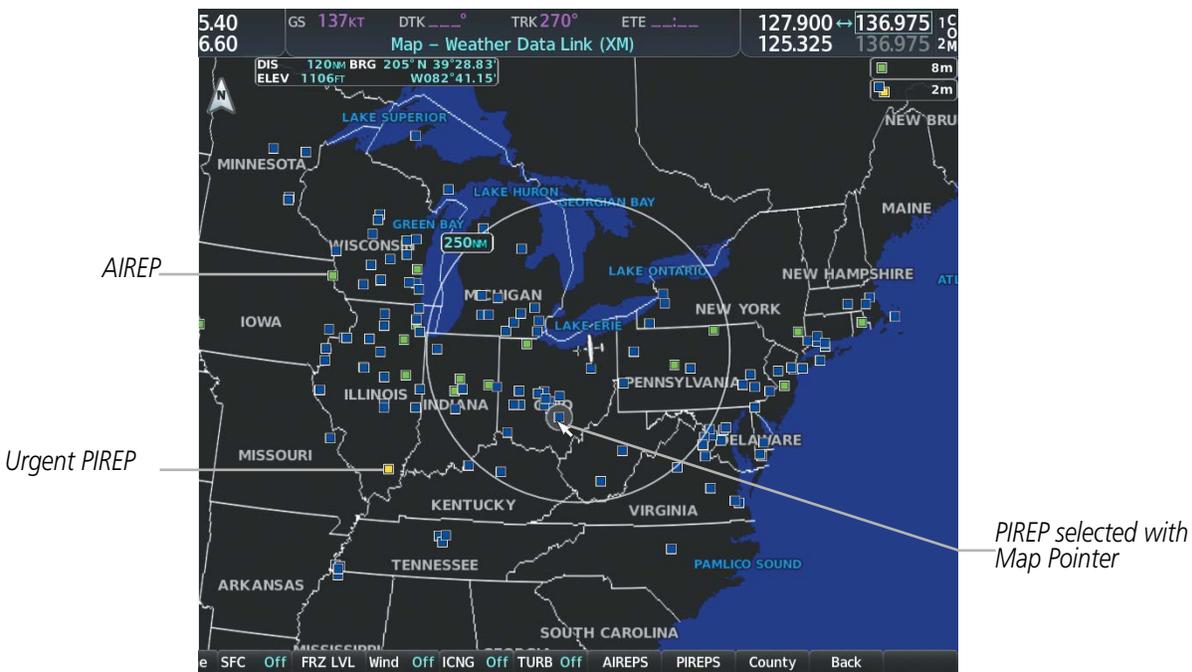


Figure 6-45 PIREPs and AIREPS on the Weather Data Link (XM) Page

Displaying PIREP and AIREP text:

- 1) Select the Weather Data Link Page.
- 2) Select the **More WX** Softkey.
- 3) Select the **PIREPS** or **AIREPS** Softkey. (Note the **AIREPS** Softkey is only available with the SiriusXM Weather service.)
- 4) Press the **Joystick** and pan to the desired weather report. A gray circle will appear around the weather report when it is selected.
- 5) Press the **ENT** Key. The Weather Information Page is shown with PIREP or AIREP text. The data is first displayed in a decoded fashion, followed by the original text. Note the original text may contain additional information not present in the decoded version.
- 6) Use the **FMS** Knob or the **ENT** Key to scroll through the PIREP or AIREP text.
- 7) Press the **FMS** Knob or the **CLR** Key to return to the Weather Data Link (XM) Page.



Figure 6-46 PIREP Text on the Weather Data Link (XM) Page

The PIREP color is determined by the type (routine or urgent).

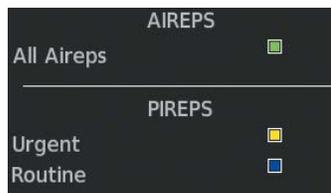


Figure 6-47 AIREPs & PIREPs Legend

TFRS



NOTE: Do not rely solely upon data link services to provide Temporary Flight Restriction (TFR) information. Always confirm TFR information through official sources such as Flight Service Stations or Air Traffic Control.

In the United States, the FAA issues Temporary Flight Restrictions (TFRs) to designate areas where flight is restricted. TFRs are issued to restrict flight for a variety of reasons including national security, law enforcement, natural disasters, and large sporting events. TFRs may be issued at any time, and TFR data displayed on the system is only intended to supplement official TFR information obtained from Flight Service Stations (FSS), and air traffic control.

The age of TFR data is not shown; however, if TFR data is not available or has expired, the system displays 'TFR N/A' in the upper-left corner of maps on which TFRs can be displayed.



Information for selected TFR

Figure 6-48 TFR Data on the Weather Data Link (XM) Page

Displaying TFR Data:

- 1) Select the Weather Data Link Page or Navigation Map Page.
- 2) Press the **Joystick** and pan the map pointer over a TFR to highlight it. The system displays TFR summary information above the map.
- 3) Press the **ENT** Key. The system displays a pop-up menu.
- 4) If necessary, turn the **FMS** Knob to select 'Review Airspaces' and press the **ENT** Key. The system displays the TFR Information window.
- 5) Press the **FMS** Knob or the **CLR** Key to remove the TFR Information window.

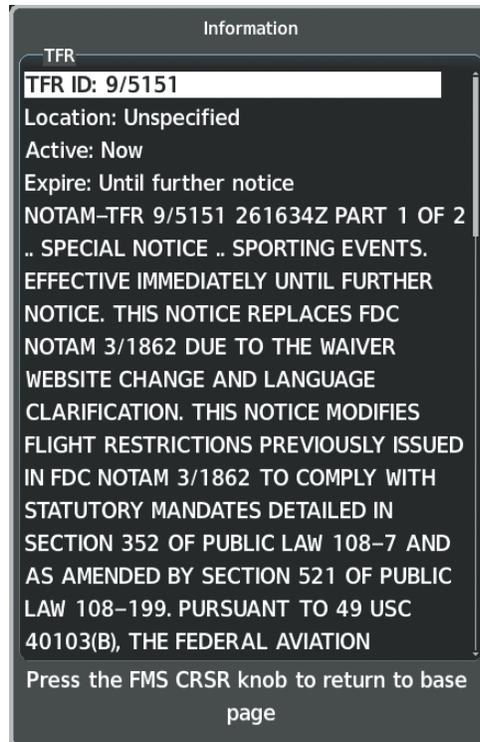


Figure 6-49 Full Text for Selected TFR

The setup menus for the Navigation Map Page control the map range settings above which TFR data is decluttered from the display. If a map range larger than the TFR product map range setting is selected, the TFR product data is removed from the map.

Maps other than the Navigation Map Page use settings based on those selected for the Navigation Map Page.

Setting up and customizing TFR data for maps on which TFR data can be displayed:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) With 'Map Settings' highlighted, press the **ENT** Key.
- 4) Turn the small **FMS** Knob to select the 'Aviation' Group and press the **ENT** Key.
- 5) Turn the large **FMS** Knob to scroll to the TFR product range setting.
- 6) Turn the small **FMS** Knob to scroll through options (Off, range settings).
- 7) Press the **ENT** Key to select an option.
- 8) Press the **FMS** Knob or **CLR** Key to return to the Navigation Map Page with the changed settings.

FIS-B WEATHER STATUS

Additional information about the status of FIS-B weather products is available on the Aux - ADS-B Status Page.

Viewing FIS-B status:

- 1) Turn the large **FMS** Knob to select the Aux Page Group.
- 2) Turn the small **FMS** Knob to select the Aux - ADS-B Status Page.

On the Weather Data Link (FIS-B) page, the pilot can enable/disable the FIS-B weather feature, which includes all FIS-B weather products and related softkeys on various maps.

Enabling/disabling the FIS-B weather feature:

- 1) Select the Weather Data Link (FIS-B) Page.
- 2) Press the **MENU** Key.
- 3) Turn the small **FMS** Knob to highlight 'Enable FIS-B Weather' or 'Disable FIS-B Weather', and press the **ENT** Key.



Figure 6-50 Viewing FIS-B Weather Status on the ADS-B Status Page

ADS-B Status Page Item	Status Message	Description
FIS-B Weather Status: FIS-B Processing	ENABLED	The FIS-B weather feature is enabled to process and display FIS-B weather products.
	DISABLED	The FIS-B weather feature is disabled.
	-----	No FIS-B weather data received from the transponder.
Weather Products: AIRMET CONUS NEXRAD METAR METAR GRAPHICAL NOTAM/TFR PIREP REGIONAL NEXRAD SIGMET TAF WINDS/TEMPS ALOFT	AVAILABLE	FIS-B weather data is available for display for the weather product.
	NOT AVAILABLE	FIS-B weather data is not available for the weather product, and/or the system is not receiving the FIS-B weather service.
	AWAITING DATA	The system is receiving the FIS-B weather service, and is waiting to receive the weather product from the FIS-B data broadcast.

Table 6-5 Aux-ADS-B Status Page Messages for FIS-B Weather

6.2 STORMSCOPE LIGHTNING DETECTION SYSTEM



WARNING: Do not rely on information from the lightning detection system display as the sole basis for hazardous weather avoidance. Range limitations and interference may cause the system to display inaccurate or incomplete information. Refer to documentation from the lightning detection system manufacturer for detailed information about the system.



NOTE: Stormscope lightning information cannot be displayed simultaneously on the same map as lightning information from data link lightning sources.

The system can display L-3 WX-500 Stormscope lightning detection system information on the Stormscope Page, and as an overlay on navigation maps. The system uses the symbols shown in the following table to depict lightning strikes and cells based on the age of the information.

Lightning Age	Symbol
Strike is less than 6 seconds old	
Strike is between 6 and 60 seconds old	
Strike is between 1 and 2 minutes old	
Strike is between 2 and 3 minutes old	

Table 6-6 Lightning Age and Symbols

USING THE STORMSCOPE PAGE

On the Stormscope Page, lightning information can be displayed at the ranges of 25 nm, 50 nm, 100 nm, and 200 nm.

Adjusting the Stormscope Map Range:

- 1) Turn the large **FMS** Knob to select the Map Page Group.
- 2) Turn the small **FMS** Knob to select the Stormscope Page.
- 3) Turn the **Joystick** clockwise to increase the map range or counter-clockwise to decrease the map range.

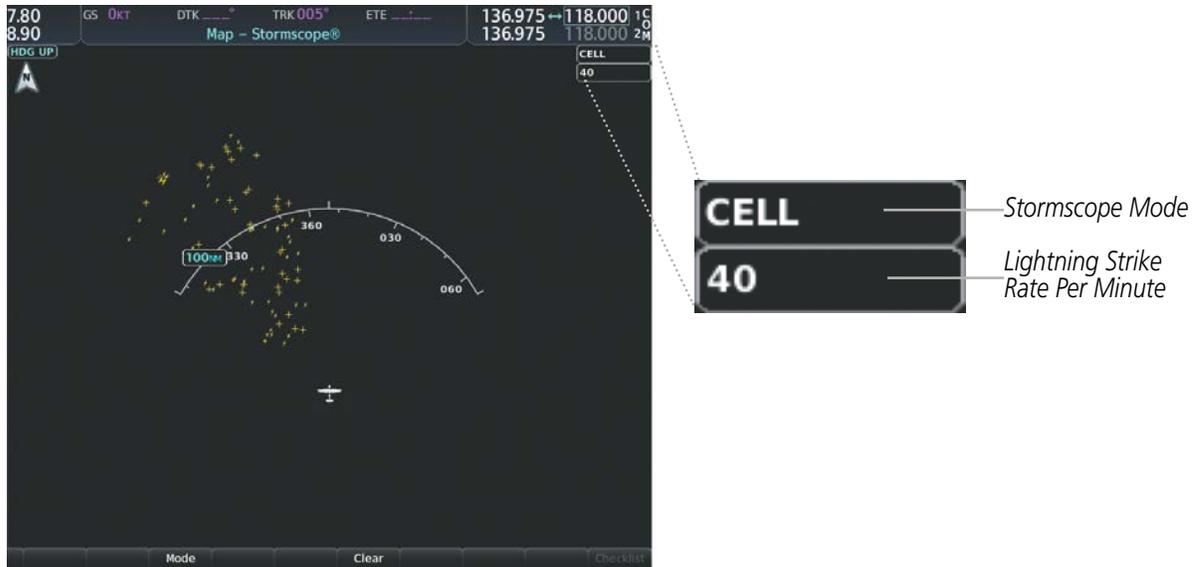


Figure 6-51 Stormscope Page with Cell Mode Selected

Selecting 'cell' or 'strike' mode:

- 1) Select the Stormscope Page.
- 2) Select the **Mode** Softkey. The **Cell** and **Strike** softkeys are displayed.
- 3) Select the **Cell** Softkey to display 'CELL' data or select the **Strike** Softkey to display 'STRIKE' data. 'CELL' or 'STRIKE' is displayed in the mode box in the upper right corner of the Stormscope Page.
- 4) Press the **Back** Softkey to return to the top level softkeys for the Stormscope Page.

Or:

- 1) Select the Stormscope Page.
- 2) Press the **MENU** Key to display the Stormscope Page Menu. Either 'Cell Mode' or 'Strike Mode' is highlighted in cyan to indicate the mode to be selected.
- 3) Press the **ENT** Key to select the highlighted mode and remove the menu. To remove the menu without changing modes, press the **MENU** Key or the **CLR** Key, or push the **FMS** Knob.

If heading input is lost, strikes and/or cells must be cleared manually after the execution of each turn. This is to ensure that the strike and/or cell positions are depicted accurately in relation to the nose of the aircraft. Clearing Stormscope lightning on any map clears this information from all displays on the system.

Manually clearing Stormscope cell or strike information:

- 1) Select the Stormscope Page.
 - 2) Select the **Clear** Softkey.
- Or:**
- a) Press the **MENU** Key.
 - b) Turn the **FMS** Knob to highlight 'Clear Lightning Data', then press the **ENT** Key.

Or:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) Turn the **FMS** Knob to highlight 'Clear Stormscope® Lightning', then press the **ENT** Key.

Displaying Stormscope information on MFD navigation maps:

- 1) Press the **Map Opt** Softkey.
- 2) Press the **STRMSCP** Softkey.

Displaying Stormscope information on PFD maps:

- 1) On the PFD, press the **Map/HSI** Softkey.
- 2) Press the **Lightning** Softkey.
- 3) Press the **STRMSCP** Softkey.

SETTING UP STORMSCOPE ON THE NAVIGATION MAP

Setting up Stormscope options on the Navigation Map:

- 1) On the Navigation Map Page, press the **MENU** Key.
- 2) With 'Map Settings' selected, press the **ENT** Key.
- 3) Turn the small **FMS** Knob to display the group selection window. Turn the small **FMS** Knob to select 'Weather', and press the **ENT** Key.
- 4) Turn the large **FMS** Knob to highlight and move between the product selections.
- 5) When an item is highlighted, turn the small **FMS** Knob to select the option.
- 6) Press the **ENT** Key.
- 7) Press the **FMS** Knob to return to the Navigation Map Page.

The following options are available:

- Stormscope On/Off field – Enables/disables the display of Stormscope lightning symbols.
- Stormscope maximum display range – Selects the maximum map range to display Stormscope symbols. Stormscope data is removed when a map range greater than the STRMSCP SMBL value is selected.
- Stormscope Mode – Selects the Cell or Strike mode of lightning activity. Cell mode identifies clusters or cells of electrical activity. Strike mode indicates the approximate location of lightning strikes.

CELL AND STRIKE MODE ON THE NAVIGATION MAP

On the Navigation Map, cell mode identifies cells of lightning activity. Stormscope identifies clusters of electrical activity that indicate cells. Strike mode indicates the approximate location of lightning strikes.

Selecting the 'cell' or 'strike' mode on the Navigation Map:

- 1) Press the **MENU** Key.
- 2) With 'Map Settings' selected, press the **ENT** Key.

- 3) Turn the **FMS** Knob to select the 'Weather' group and press the **ENT** Key.
- 4) Turn the large **FMS** Knob to select the Stormscope Mode field.
- 5) Turn the small **FMS** Knob to change between 'Cell' and 'Strike' options. When the desired item is selected, press the **ENT** Key.
- 6) Press the **FMS** knob to return to the Navigation Map Page.

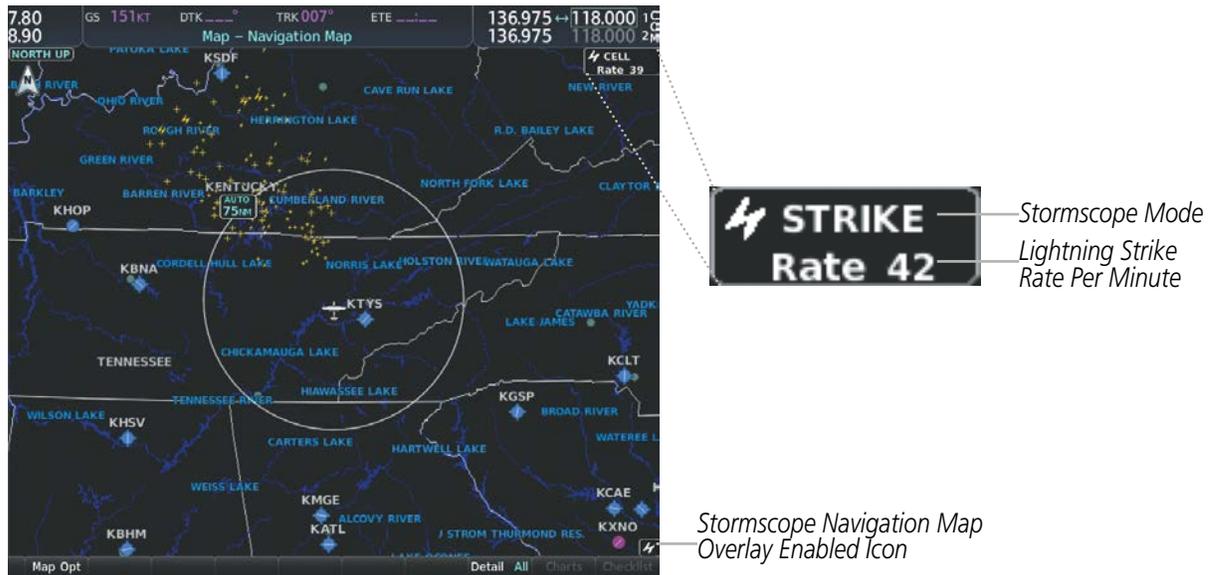


Figure 6-52 Navigation Map Page with Stormscope Lightning Data

If heading input is lost, strikes and/or cells must be cleared manually after the execution of each turn. This is to ensure that the strike and/or cell positions are depicted accurately in relation to the nose of the aircraft.

Manually clearing Stormscope data on the Navigation Map:

- 1) Press the **MENU** Key.
- 2) Turn the **FMS** Knob to highlight 'Clear Stormscope® Lightning'.
- 3) Press the **ENT** Key.

Selecting a Stormscope range on the Navigation Map:

- 1) Press the **MENU** Key.
- 2) With 'Map Settings' highlighted, press the **ENT** Key.
- 3) Turn the **FMS** Knob to highlight the select the 'Weather' group, and press the **ENT** Key.
- 4) Turn the large **FMS** Knob to highlight the Stormscope maximum map display range distance.
- 5) Turn the small **FMS** Knob to select the Stormscope maximum map display range distance.
- 6) Press the **ENT** Key.
- 7) Press the **FMS** Knob to return to the Navigation Map Page.

To change the display range on the Navigation Map Page, turn the **Joystick** clockwise to increase the map range or counter-clockwise to decrease the map range.

6.3 TERRAIN DISPLAYS



WARNING: Do not use terrain avoidance displays as the sole source of information for maintaining separation from terrain and obstacles. Garmin obtains terrain and obstacle data from third party sources and cannot independently verify the accuracy of the information.



NOTE: Terrain data is not displayed when the aircraft is outside of the installed terrain database coverage area.



NOTE: Terrain and obstacle alerting is not available north of 89° North latitude and south of 89° South latitude. This is due to limitations present within the Terrain database and the system's ability to process the data representing the affected areas.



NOTE: Terrain and obstacle alerting requires the Terrain-SVT or TAWS-B option. No terrain or obstacle alerting occurs for the Terrain Proximity feature.

The terrain system increases situational awareness and aids in reducing controlled flight into terrain (CFIT) and obstacles.

One of the following terrain systems is installed on this aircraft:

- Terrain Proximity
- Terrain-SVT (included with the Garmin SVT option when the Terrain Awareness and Warning System Class-B (TAWS-B) is not installed; refer to the Flight Instruments section for more information about Garmin SVT.)
- TAWS-B (optional)

The installed terrain system provides color indications on map displays when terrain or obstacles are within a certain altitude threshold from the aircraft. Terrain-SVT and TAWS-B furthermore provide advisory visual annunciations and voice alerts to indicate the presence of threatening terrain or obstacles relevant to the projected flight path. This alerting capability is **not** present in the Terrain Proximity feature. Compared to Terrain-SVT alerting, TAWS-B uses more sophisticated algorithms to assess aircraft distance from terrain and obstacles. Only the TAWS-B system complies with TSO-C15b certification standards, and includes additional alerting capabilities than the Terrain-SVT system.

The terrain system requires the following for proper operation:

- Valid 3-D GPS position
- Valid terrain and obstacle databases

The terrain system uses terrain and obstacle information supplied by government sources. Terrain information is based on terrain elevation information in a database that may contain inaccuracies. Individual obstructions may be shown if available in the database. Garmin verifies the data to confirm accuracy of the content. However, the displayed information should never be understood as being all-inclusive and data may still contain inaccuracies.

SYSTEM OVERVIEW
 FLIGHT INSTRUMENTS
 EIS
 AUDIO PANEL & CNS
 FLIGHT MANAGEMENT
HAZARD AVOIDANCE
 AFCS
 ADDITIONAL FEATURES
 APPENDICES
 INDEX

The terrain system uses information provided from the GPS receiver to provide a horizontal position and altitude. GPS altitude is derived from satellite measurements. GPS altitude is then converted to the height above geodetic sea level (GSL), which is the height above mean sea level (MSL) calculated geometrically. The system uses GSL altitude to determine alerts for the Terrain-SVT and TAWS-B systems. GSL altitude accuracy is affected by satellite geometry, but is not subject to variations in pressure and temperature that normally affect pressure altitude sensors. GSL altitude does not require local altimeter settings to determine MSL altitude. It is a widely-used MSL altitude source. Therefore, GSL altitude provides a highly accurate and reliable MSL altitude source to calculate terrain and obstacle alerts.

The terrain and obstacle databases used by the terrain system are referenced to MSL. Using the GPS position and GSL altitude, terrain system displays a 2-D picture of the surrounding terrain and obstacles relative to the position and altitude of the aircraft. Furthermore, for the Terrain-SVT or TAWS-B systems, the system uses the GPS position and GSL altitude to calculate and “predict” the aircraft’s flight path in relation to the surrounding terrain and obstacles. In this manner, the Terrain-SVT or TAWS-B systems can provide advanced alerts of predicted dangerous terrain conditions.

Baro-corrected altitude (or indicated altitude) is derived by adjusting the altimeter setting for local atmospheric conditions. The most accurate baro-corrected altitude can be achieved by frequently updating the altimeter setting to the nearest reporting station along the flight path. However, because actual atmospheric conditions seldom match the standard conditions defined by the International Standard Atmosphere (ISA) model (where pressure, temperature, and lapse rates have fixed values), it is common for the baro-corrected altitude (as read from the altimeter) to differ from the GSL altitude. This variation results in the aircraft’s GSL altitude differing from the baro-corrected altitude.

RELATIVE TERRAIN SYMBOLOGY

The terrain system uses colors and symbols to represent terrain and obstacles (with heights greater than 200 feet above ground level, AGL) present in the databases relative to aircraft altitude. The system dynamically adjusts these colors as the aircraft altitude changes, and after takeoff and landing.

While the aircraft is on the ground, the system displays relative terrain 400 feet or more above the aircraft altitude using red, and terrain at less than 400 feet above aircraft altitude using black, as shown on the On-Ground Legend. When the aircraft is in the air, the system displays relative terrain information using red, yellow, green, and black, as shown on the In-Air Legend. As the aircraft transitions from on-ground to in-air, or from in-air to on-ground, the display of relative terrain momentarily fades into the corresponding colors. For Terrain-SVT or TAWS-B systems, if an alert occurs, the relative terrain colors transition to the In-Air Legend if in the On-Ground Legend was shown in order to provide the flight crew with the most information possible.

On-Ground Legend



In-Air Legend



Figure 6-53 Relative Terrain Legend

The following figure shows the relative terrain coloring for the Terrain Proximity system.

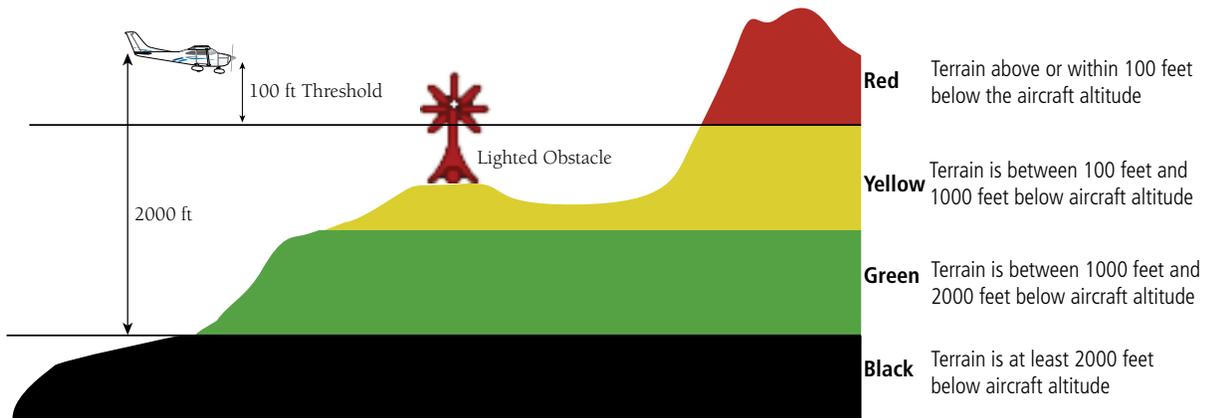


Figure 6-54 Terrain Altitude/Color Correlation for Terrain Proximity

The following figure shows relative terrain coloring for the Terrain-SVT and TAWS-B systems.

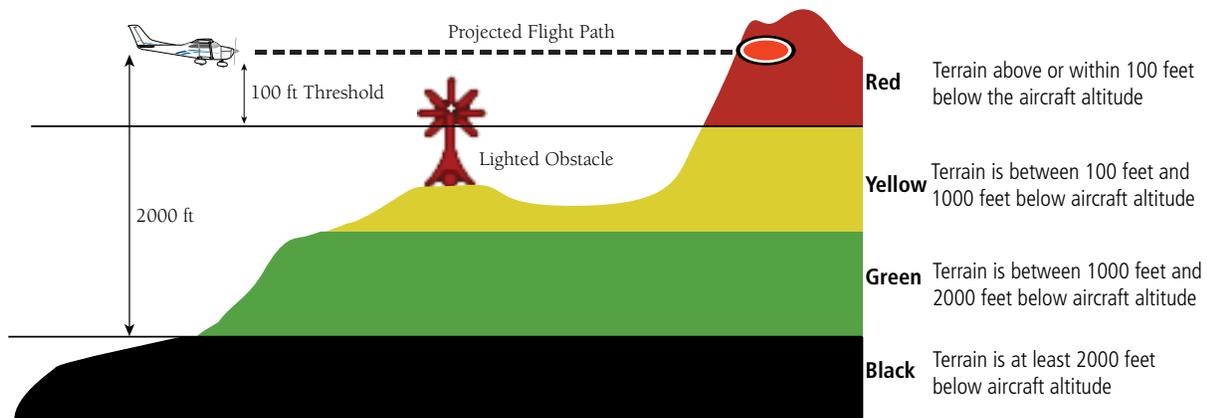


Figure 6-55 Terrain Altitude/Color Correlation for Terrain-SVT or TAWS-B Systems

The following tables show the relative obstacle coloring used by the terrain systems.

Unlighted Obstacle		Lighted Obstacle		Obstacle Location
< 1000' AGL	> 1000' AGL	< 1000' AGL	> 1000' AGL	
				Red obstacle is above or within 100 ft below the aircraft altitude
				Yellow obstacle is between 100 ft and 1000 ft below the aircraft altitude
				White obstacle is more than 1000 ft below aircraft altitude

Table 6-7 Relative Obstacle Symbols and Colors

Unlighted Wind Turbine Obstacle	Lighted Wind Turbine Obstacle	Wind Turbine Obstacle Location
		Red obstacle is above or within 100 ft below the aircraft altitude
		Yellow obstacle is between 100 ft and 1000 ft below the aircraft altitude
		White obstacle is more than 1000 ft below aircraft altitude

Table 6-8 Wind Turbine Obstacles and Colors

The Terrain-SVT and TAWS-B systems show potential impacts areas for terrain and obstacles using yellow and red as shown in the the following table.

Potential Impact Area Examples	Alert Type	Example Annunciation
 or 	Warning	
 or 	Caution	

Table 6-9 Terrain-SVT and TAWS-B Potential Impact Area with Annunciations

The Map - Terrain Proximity or Terrain-SVT or TAWS-B Page is the principal map page for viewing terrain information. Terrain and obstacle information can be displayed on the following maps and pages:

- PFD Maps
- Navigation Map Page
- Terrain Proximity/Terrain-SVT/TAWS-B Page
- Trip Planning Page
- Flight Plan Page

Displaying terrain and obstacle information (MFD maps other than the terrain page):

- 1) Press the **Map Opt** Softkey (for the PFD Inset Map, press the **Map/HSI** Softkey).
- 2) Press the **TER** Softkey until **REL** is shown to display terrain and obstacle data.

When relative terrain is selected on maps other than the terrain page, an icon to indicate the feature is enabled for display and a legend for the relative terrain colors are shown.

The Navigation Map Page Setup Menu provides a means in addition to the softkey for enabling/disabling display of terrain and obstacles. The setup menu also controls the map range settings above which terrain and obstacle data are decluttered from the display. If a map range larger than the map range setting is selected, the data is removed from the map.

Terrain information can be selected for display independently of obstacle data; however, obstacles recognized by Terrain Proximity as yellow or red are shown when terrain is selected for display and the map range is within the setting limit.

Maps besides the Terrain Proximity Page use settings based on those selected for the Navigation Map Page. The maximum display ranges for obstacles on each map are dependent on the range setting made for the Navigation Map. If the maximum range for obstacle display on the Navigation Map is adjusted to below 20 nm, the highest obstacle display range settings on the other applicable maps are also adjusted proportionally.

Customizing terrain and obstacle display on the Navigation Map Page:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) With 'Map Settings' highlighted, press the **ENT** Key.
- 4) Turn the small **FMS** Knob to select the 'Map' Group and press the **ENT** Key.
- 5) Turn the large **FMS** Knob or press the **ENT** Key to scroll through product selections.
 - Terrain Display – Turns the display of relative ('REL') terrain data on or off and sets maximum range at which terrain is shown
 - Obstacle Data – Turns the display of obstacle data on or off and sets maximum range at which obstacles are shown
- 6) Turn the small **FMS** Knob to scroll through options for each product (On/Off, range settings, etc.).
- 7) Press the **ENT** Key to select an option.
- 8) Press the **FMS** Knob or **CLR** Key to return to the Navigation Map Page with the changed settings.

Additional information about obstacles can be displayed by panning over the display on the map. The map panning feature is enabled by pressing the **Joystick**. The map range is adjusted by turning the **Joystick**. If the map range is adjusted while panning is enabled, the map is re-centered on the Map Pointer.



Figure 6-56 Terrain Information on the Navigation Map Page

TERRAIN PAGE

The Map - Terrain Proximity, or Map - Terrain-SVT, or Map - TAWS-B Page is specialized to show terrain, and obstacle in relation to the aircraft's current altitude, without clutter from the basemap. This page is the principal page for viewing terrain information. Aviation data (airports, VORs, and other NAVAIDs) can be enabled for reference.

For Terrain-SVT and TAWS-B systems only, this page also shows potential impact areas. If an obstacle and the projected flight path of the aircraft intersect, the display automatically adjusts to a map range if necessary to emphasize the display of the potential impact area.

Aircraft orientation on this map is always heading up unless there is no valid heading, in which case the orientation is track up. Map range is adjustable with the **Joystick** from 1 to 200 nm, as indicated by the map range rings (or arcs).

Displaying the terrain page:

- 1) Turn the large **FMS** Knob to select the Map Page Group.
- 2) Turn the small **FMS** Knob to select the Terrain Proximity Page/Terrain-SVT/TAWS-B Page.

Showing/hiding aviation information on the terrain page:

- 1) Press the **MENU** Key.
- 2) Select 'Show Aviation Data' or 'Hide Aviation Data' (choice dependent on current state) and press the ENT Key.



Figure 6-57 Terrain Proximity Page

TERRAIN-SVT AND TAWS-B ALERTING DISPLAYS

Alerts are issued when flight conditions meet parameters that are set within Terrain-SVT or TAWS-B software algorithms. Terrain alerts typically employ a CAUTION or a WARNING alert severity level, or both. When an alert is issued, visual annunciations are displayed and voice alerts are simultaneously issued.

When an alert is issued, annunciations appear on the PFD and MFD. The terrain alert annunciation appears to the left of the Selected Altitude box on the PFD, and bottom left on the MFD. If the terrain page is not displayed at the time, a pop-up alert appears on the MFD. To acknowledge the pop-up alert:

- Press the **CLR** Key (returns to the currently viewed page), or
- Press the **ENT** Key (accesses the Terrain-SVT or TAWS-B Page)

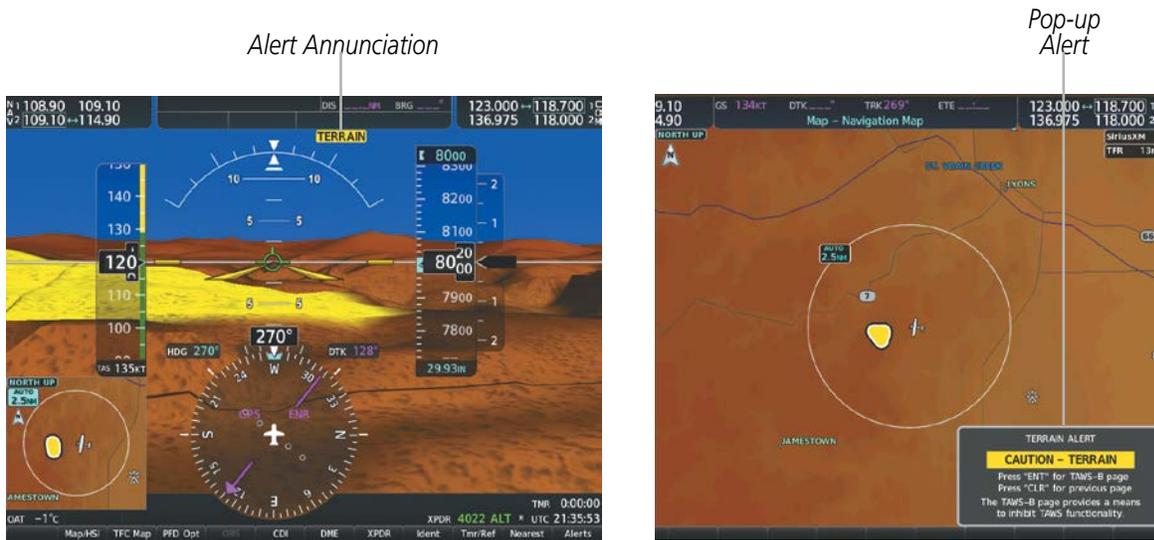


Figure 6-58 TAWS-B Alert Annunciations



Figure 6-59 Navigation Map Page (After TAWS-B Pop-up Alert Acknowledgment)

The following table lists the possible Terrain-SVT alerts.

Alert Type	PFD/MFD* Alert Annunciation	MFD Pop-Up Alert (except Terrain-SVT Page)	Voice Alert
Reduced Required Terrain Clearance Warning (RTC)	TERRAIN	WARNING - TERRAIN	"Warning; Terrain, Terrain"
Imminent Terrain Impact Warning (ITI)	TERRAIN	WARNING - TERRAIN	"Warning; Terrain, Terrain"
Reduced Required Obstacle Clearance Warning (ROC)	TERRAIN	WARNING - OBSTACLE	"Warning; Obstacle, Obstacle"
Imminent Obstacle Impact Warning (IOI)	TERRAIN	WARNING - OBSTACLE	"Warning; Obstacle, Obstacle"
Reduced Required Terrain Clearance Caution (RTC)	TERRAIN	CAUTION - TERRAIN	"Caution; Terrain, Terrain"
Imminent Terrain Impact Caution (ITI)	TERRAIN	CAUTION - TERRAIN	"Caution; Terrain, Terrain"
Reduced Required Obstacle Clearance Caution (ROC)	TERRAIN	CAUTION - OBSTACLE	"Caution; Obstacle, Obstacle"
Imminent Obstacle Impact Caution (IOI)	TERRAIN	CAUTION - OBSTACLE	"Caution; Obstacle, Obstacle"

* Annunciation is displayed on the MFD when terrain display is enabled.

Table 6-10 Terrain-SVT Alerts Summary

The following table lists the TAWS-B alerts.

Alert Type	PFD/MFD** Alert Annunciation	MFD Pop-Up Alert (except TAWS-B Page)	Voice Alert
Excessive Descent Rate Warning (EDR)	PULL UP	PULL-UP	"Pull Up"
Reduced Required Terrain Clearance Warning (RTC)	PULL UP	TERRAIN - PULL-UP* or TERRAIN AHEAD - PULL-UP	"Terrain, Terrain; Pull Up, Pull Up"* or "Terrain Ahead, Pull Up; Terrain Ahead, Pull Up"
Imminent Terrain Impact Warning (ITI)	PULL UP	TERRAIN - PULL-UP or TERRAIN AHEAD - PULL-UP*	"Terrain, Terrain; Pull Up, Pull Up" or "Terrain Ahead, Pull Up; Terrain Ahead, Pull Up"*
Reduced Required Obstacle Clearance Warning (ROC)	PULL UP	OBSTACLE - PULL-UP* or OBSTACLE AHEAD - PULL-UP	"Obstacle, Obstacle; Pull Up, Pull Up"* or "Obstacle Ahead, Pull Up; Obstacle Ahead, Pull Up"
Imminent Obstacle Impact Warning (IOI)	PULL UP	OBSTACLE - PULL-UP or OBSTACLE AHEAD - PULL-UP*	"Obstacle, Obstacle; Pull Up, Pull Up" or "Obstacle Ahead, Pull Up; Obstacle Ahead, Pull Up"*

SYSTEM OVERVIEW

FLIGHT INSTRUMENTS

EIS

AUDIO PANEL & CNS

FLIGHT MANAGEMENT

HAZARD AVOIDANCE

AFCS

ADDITIONAL FEATURES

APPENDICES

INDEX

Alert Type	PFD/MFD** Alert Annunciation	MFD Pop-Up Alert (except TAWS-B Page)	Voice Alert
Reduced Required Terrain Clearance Caution (RTC)	TERRAIN	CAUTION - TERRAIN * OR TERRAIN AHEAD	"Caution, Terrain; Caution, Terrain" * OR "Terrain Ahead; Terrain Ahead"
Imminent Terrain Impact Caution (ITI)	TERRAIN	CAUTION - TERRAIN OR TERRAIN AHEAD *	"Caution, Terrain; Caution, Terrain" OR "Terrain Ahead; Terrain Ahead" *
Reduced Required Obstacle Clearance Caution (ROC)	TERRAIN	CAUTION - OBSTACLE * OR OBSTACLE AHEAD	"Caution, Obstacle; Caution, Obstacle" * OR "Obstacle Ahead; Obstacle Ahead"
Imminent Obstacle Impact Caution (IOI)	TERRAIN	CAUTION - OBSTACLE OR OBSTACLE AHEAD *	"Caution, Obstacle; Caution, Obstacle" OR "Obstacle Ahead; Obstacle Ahead" *
Premature Descent Alert Caution (PDA)	TERRAIN	TOO LOW - TERRAIN	"Too Low, Terrain"
Altitude Voice Callout (VCO) "500"	None	None	"Five-Hundred"
Excessive Descent Rate Caution (EDR)	TERRAIN	SINK RATE	"Sink Rate"
Negative Climb Rate Caution (NCR)	TERRAIN	DON'T SINK * OR TOO LOW - TERRAIN	"Don't Sink" * OR "Too Low, Terrain"

* Alerts with multiple messages are configurable at installation and are installation-dependent. Alerts for the default configuration when more than one option is available are indicated with asterisks.
 ** Annunciation is displayed on the MFD when terrain display is enabled.

Table 6-11 TAWS-B Alerts Summary

FORWARD LOOKING TERRAIN AVOIDANCE

The Forward Looking Terrain Avoidance (FLTA) feature of Terrain-SVT or TAWS-B compares the projected flight path as derived from GPS data with terrain features and obstacles from the terrain and obstacle databases. The system issues FLTA alerts when the projected flight path conflicts with terrain or obstacles.

The projected flight path is a calculated area ahead of, to the sides, and below the aircraft. The size of the projected flight path varies based on factors including ground speed (the path ahead is larger when the ground speed is higher), whether the aircraft is level, turning, or descending, and the proximity to the nearest runway along the current track. As the aircraft approaches the runway, the projected flight path becomes narrower until the system automatically disables FLTA alerts or the pilot manually inhibits them.

There are two types of FLTA alerts, Reduced Required Terrain/Obstacle Clearance (RTC or ROC respectively) and Imminent Terrain/Obstacle Impact (ITI or IOI respectively).



Figure 6-60 FLTA Alert Minimum Terrain and Obstacle Clearance Values

The system automatically disables FLTA alerts when the aircraft is less than 200 feet above the destination runway elevation while within 0.5 nm of the approach runway or the aircraft is between runway ends.

When Terrain-SVT or TAWS-B FLTA alerts are manually inhibited, the annunciation is shown on the PFD and in the MFD for maps displaying relative terrain



Figure 6-61 FLTA Alerting is Inhibited when Annunciation is displayed

ADDITIONAL TAWS-B ALERTING

In addition to the FLTA alerting discussed previously, TAWS-B provides the following additional types of alerts.

PREMATURE DESCENT ALERTING

A **Premature Descent Alert (PDA)** is issued when the system detects that the aircraft is significantly below the normal approach path to a runway.

PDA alerting begins when the aircraft is below 700 feet AGL within 15 nm of the destination airport and ends when the aircraft is 0.5 nm from the runway threshold.

- SYSTEM OVERVIEW
- FLIGHT INSTRUMENTS
- EIS
- AUDIO PANEL & CNS
- FLIGHT MANAGEMENT
- HAZARD AVOIDANCE
- AFCS
- ADDITIONAL FEATURES
- APPENDICES
- INDEX

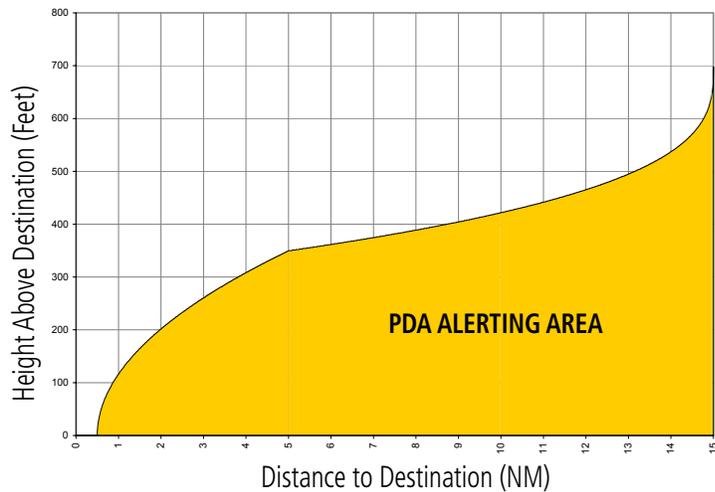


Figure 6-62 PDA Alerting Threshold

NEGATIVE CLIMB RATE AFTER TAKEOFF ALERT (NCR)

The **Negative Climb Rate (NCR) After Takeoff** alert (also referred to as “Altitude Loss After Takeoff”) provides alerts when the system determines the aircraft is losing altitude (closing upon terrain) after takeoff. The voice alert **“Don’t Sink”** is given for NCR alerts, accompanied by visual annunciations. NCR alerting is only active when departing from an airport and when the following conditions are met:

- Height above the terrain is less than 700 feet
- Distance from the departure airport is 5 nm or less
- Heading change from the departure heading is less than 110 degrees

NCR alerts can be triggered by either altitude loss or sink rate.

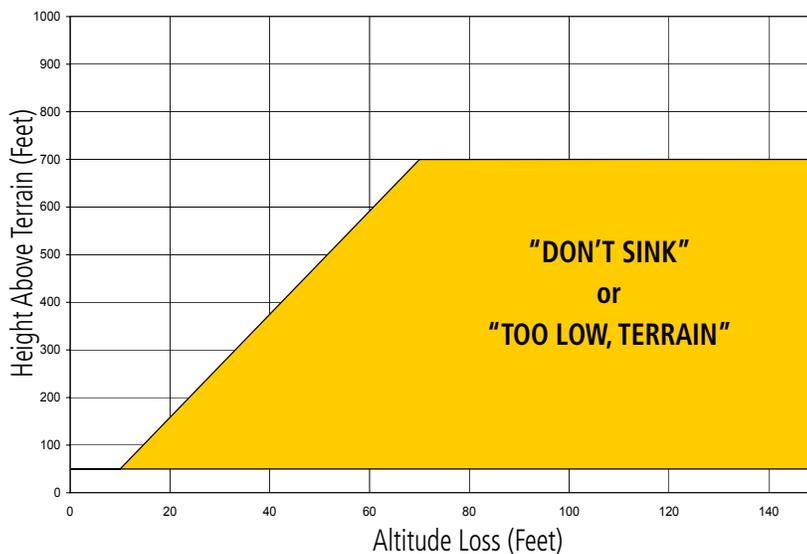


Figure 6-63 Negative Climb Rate (NCR) Altitude Loss

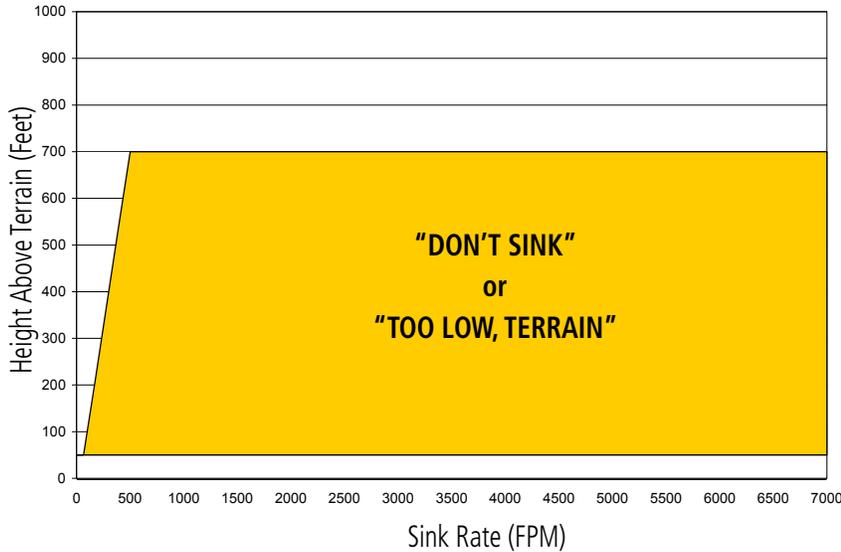


Figure 6-64 Negative Climb Rate (NCR) Sink Rate

SYSTEM STATUS

TERRAIN-SVT

During power-up, Terrain-SVT conducts a self-test of its visual annunciations and voice alerts. An voice alert is issued at test completion.

Terrain-SVT continually monitors several system-critical items such as database validity, hardware status, and GPS status. If the terrain/obstacle database is not available, the system issues the voice alert **“Terrain System Failure”** along with the ‘TER FAIL’ alert annunciation.

Terrain-SVT requires a 3-D GPS navigation solution along with specific vertical accuracy minimums. Should the navigation solution become degraded or if the aircraft is out of the database coverage area, the annunciation ‘TER N/A’ is generated in the annunciation window and on the Terrain-SVT Page. The voice alert **“Terrain System Not Available”** is generated. When sufficient GPS signal is returns and the aircraft is within the database coverage area, the voice alert **“Terrain System Available”** is generated.

Alert Type	PFD/MFD† Alert Annunciation	Terrain-SVT Page Center Banner Annunciation	Voice Alert
System Test in Progress	TER TEST	TERRAIN TEST	None
System Test Pass	None	None	"Terrain System Test OK"
Terrain Alerting Inhibited	TER INH	None	None
No GPS position	TER N/A	NO GPS POSITION	"Terrain System Not Available" *
Excessively degraded GPS signal; or Out of database coverage area	TER N/A	None	"Terrain System Not Available" *
Terrain System Test Fail; Terrain or Obstacle database unavailable or invalid; Invalid software configuration; or System audio fault	TER FAIL	TERRAIN FAIL	"Terrain System Failure"
MFD Terrain or Obstacle database unavailable or invalid, and Terrain-SVT operating with PFD Terrain or Obstacle databases	None	TERRAIN DATABASE FAILURE	None

† Annunciation is shown on Terrain-SVT Page and the Navigation Map Page when Terrain is enabled.

* "Terrain System Available" will be heard when sufficient GPS signal is received, or Terrain database coverage area re-entered.

Table 6-12 Terrain-SVT System Status Annunciations

TAWS-B

During power-up, TAWS-B conducts a self-test of its visual annunciations and voice alerts. An voice alert is issued at test completion.

TAWS-B continually monitors several system-critical items such as database validity, hardware status, and GPS status. If the terrain/obstacle database is not available, the voice alert "**TAWS System Failure**" is generated along with the 'TAWS FAIL' alert annunciation.

TAWS-B requires a 3-D GPS navigation solution along with specific vertical accuracy minimums. Should the navigation solution become degraded or if the aircraft is out of the database coverage area, the system displays the 'TAWS N/A' annunciation, and issues the "**TAWS Not Available**" voice alert. When the GPS signal integrity returns and the aircraft is within the database coverage area, the system issues the voice alert, "**TAWS Available**".

Alert Type	PFD/MFD* Alert Annunciation	TAWS-B Page Center Banner Annunciation	Voice Alert
System Test in progress	TAWS TEST	TAWS TEST	None
System Test pass	None	None	"TAWS System Test Test OK"
TAWS-B FLTA Alerting Inhibited	TAWS INH	None	None
No GPS position	TAWS N/A	NO GPS POSITION	"TAWS Not Available"
Excessively degraded GPS signal; or Out of database coverage area	TAWS N/A	None	"TAWS Not Available"
TAWS-B System Test Fail; Terrain or Obstacle database unavailable or invalid; Invalid software configuration; or System audio fault	TAWS FAIL	TAWS FAIL	"TAWS System Failure"
MFD Terrain or Obstacle database unavailable or invalid. TAWS operating with PFD Terrain or Obstacle databases	None	TERRAIN DATABASE FAILURE	None

† Annunciation is shown on TAWS-B Page and the Navigation Map Page when Terrain is enabled.

* "TAWS Available" will be heard when sufficient GPS signal is received, or Terrain database coverage area re-entered.

Table 6-13 TAWS-B System Status Annunciations

6.4 TRAFFIC INFORMATION SERVICE (TIS)



WARNING: Do not rely solely upon the display of traffic information for collision avoidance maneuvering. The traffic display does not provide collision avoidance resolution advisories and does not under any circumstances or conditions relieve the pilot's responsibility to see and avoid other aircraft.



NOTE: TIS is available only when the aircraft is within the service volume of a TIS-capable terminal radar site. Aircraft without an operating transponder are invisible to both Traffic Advisory Systems (TAS), Traffic Alert and Collision Avoidance Systems (TCAS) and TIS. Aircraft without altitude reporting capability are shown without altitude separation data or climb descent indication.



NOTE: Mode S TIS is disabled if another traffic system such as TAS or Automatic Dependent Surveillance-Broadcast (ADS-B) is installed.

Traffic Information Service (TIS) is designed to help in detection and avoidance of other aircraft. TIS uses the Mode S transponder for the traffic data link. TIS receives traffic information from ground stations, and is updated every five seconds. The system displays up to eight traffic symbols within a 7.5-nm radius, from 3000 feet below to 3500 feet above the requesting aircraft. The system displays TIS traffic with the symbology shown in the following table.

TIS Symbol	Description
	Non-Threat Traffic
	Traffic Advisory (TA)
	Traffic Advisory Off Scale

Table 6-14 TIS Traffic Symbols

Traffic Advisories (TA) alert the crew to intruding aircraft. When traffic meets the advisory criteria for the TA, a solid amber circle symbol appears. A TA which is detected but is outside the range of the map on which traffic is displayed are indicated with a message in the lower left corner of the map.

TIS also provides a vector line showing the direction in which the traffic is moving, to the nearest 45°. Traffic information for which TIS is unable to determine the bearing (non-bearing traffic) is displayed in the center of the Traffic Map Page or in a banner at the lower left corner of maps other than the Traffic Map Page on which traffic can be displayed.

The altitude difference between the requesting aircraft and other intruder aircraft is displayed above/below the traffic symbol in hundreds of feet. If the other aircraft is above the requesting aircraft, the altitude separation appears above the traffic symbol; if below, the altitude separation appears below. Altitude trend is displayed as an up/down arrow (for speeds greater than 500 fpm in either direction) to the right of the target symbol. Traffic symbols for aircraft without altitude reporting capability appear without altitude separation or climb/descent information.

DISPLAYING TRAFFIC DATA

The Map - Traffic Map Page is the principal map page for viewing traffic information. Traffic information can also be displayed on the following other maps for additional reference on the MFD when the traffic TIS is operating:

- PFD Maps
- Navigation Map Page
- Traffic Map Page
- Trip Planning Page
- Nearest Pages
- Active Flight Plan Page

Traffic information can also be displayed on the PFD when the Terrain-SVT option is installed and enabled. See the Additional Features Section for details.

Enabling/disabling traffic overlays (MFD navigation maps):

- 1) Select the **Map Opt** Softkey.
- 2) Select the **Traffic** Softkey. Traffic is now displayed on the navigation map.

When traffic is selected on maps other than the Traffic Map Page, an icon is shown to indicate the feature is enabled for display.



Figure 6-65 TIS Traffic on Navigation Map Page

The Navigation Map Page Setup Menu provides a means in addition to the softkey for enabling/disabling display of traffic. The setup menu also controls the map range settings above which traffic data (symbols and labels) are decluttered from the display. If a map range larger than the map range setting is selected, the data is removed from the map. Maps besides the Traffic Map Page use settings based on those selected for the Navigation Map Page.

Enabling/disabling traffic information on the PFD Inset Map or HSI Map:

- 1) On the PFD, press the **Map/HSI** Softkey.
- 2) Press the **Traffic** Softkey to enable/disable the display traffic information on the Inset Map or HSI Map.

Customizing traffic display on the Navigation Map Page:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) With 'Map Setup' highlighted, press the **ENT** Key.
- 4) Turn the small **FMS** Knob to select the 'Traffic' Group and press the **ENT** Key.
- 5) Turn the large **FMS** Knob or press the **ENT** Key to scroll through product selections.
 - Traffic – Turns the display of traffic data on or off
 - Traffic Mode – Selects the traffic mode for display; select from:
 - All Traffic - Displays all traffic
 - TA Only - Displays Traffic Alerts only
 - Traffic Symbols – Selects the maximum range at which traffic symbols are shown
 - Traffic Labels – Selects the maximum range at which traffic labels are shown (with the option to turn off)
- 6) Turn the small **FMS** Knob to scroll through options for each product (On/Off, range settings, etc.).
- 7) Press the **ENT** Key to select an option.
- 8) Press the **FMS** Knob or **CLR** Key to return to the Navigation Map Page with the changed settings.

TRAFFIC MAP PAGE

The Traffic Map Page is specialized to show surrounding TIS traffic data in relation to the aircraft's current position and altitude, without clutter from the basemap. Aircraft orientation on this map is always heading up unless there is no valid heading. Map range is adjustable with the **Joystick** from 2 to 12 nm, as indicated by the map range rings.

The traffic mode is annunciated in the upper left corner of the Traffic Map Page. When the aircraft is on the ground, TIS automatically enters Standby Mode. Once the aircraft is airborne, TIS switches from Standby to Operating Mode and the system begins to display traffic information. Refer to the System Status discussion for more information.

Displaying traffic on the Traffic Map Page:

- 1) Turn the large **FMS** Knob to select the Map Page Group.
- 2) Turn the small **FMS** Knob to select the Traffic Map Page.
- 3) Confirm TIS is in Operating Mode:
 - a) Press the **TIS OPER** Softkey to begin displaying traffic.
 - Or:**
 - a) Press the **MENU** Key.
 - b) Select 'Operate Mode' (shown if TIS is in Standby Mode) and press the **ENT** Key.

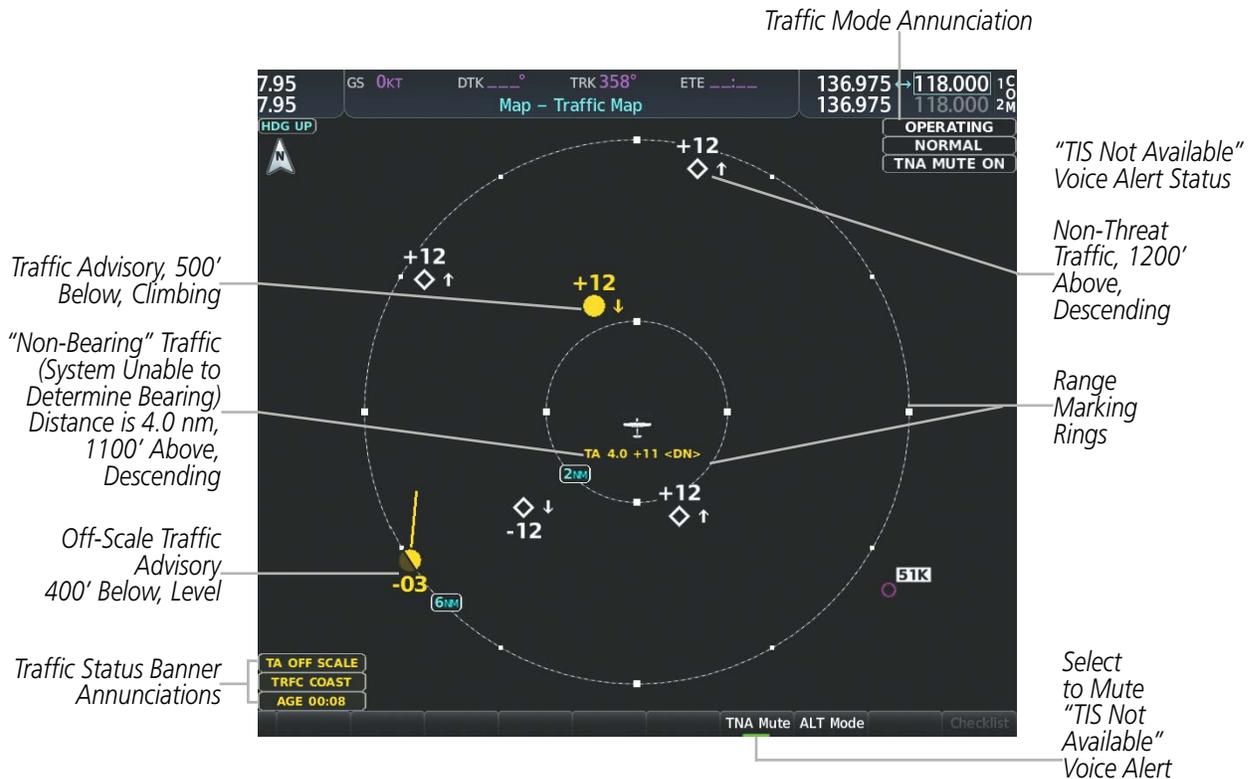


Figure 6-66 Traffic Map Page

TIS ALERTS

When the number of TAs on the Traffic Map Page increases from one scan to the next, the following occur:

- A single **"Traffic"** voice alert is generated.
- A 'TRAFFIC' Annunciation appears to the right of the airspeed tape, flashes for five seconds, and remains displayed until no TAs are detected in the area.
- The PFD Inset Map or HSI Map is automatically displayed with traffic.

To reduce the number of nuisance alerts due to proximate aircraft, the **"Traffic"** voice alert is generated only when the number of TAs increases. For example, when the first TA is displayed, a voice and visual annunciation are generated. As long as a single TA remains on the display, no additional voice alerts are generated. If a second TA appears on the display or if the number of TAs initially decreases and then subsequently increases, another voice alert is generated.

TRAFFIC

*Inset Map
Displays When
TA is Detected*



Figure 6-67 Traffic Annunciation (PFD)

A “**TIS Not Available**” (TNA) voice alert is generated when the TIS service becomes unavailable or is out of range. TIS may be unavailable in the radar coverage area due to the following:

- Radar site TIS Mode S sensor is not operational or is out of service
- Traffic or requesting aircraft is beyond the maximum range of the TIS-capable Mode S radar site.
- Traffic or requesting aircraft is above the radar site in the cone of silence and out of range of an adjacent site.
- Traffic or requesting aircraft is below radar coverage. In flat terrain, the coverage extends from about 3000 feet upward at 55 miles. Terrain and obstacles around the radar site can further decrease radar coverage in all directions.
- Traffic does not have an operating transponder.

The “**TIS Not Available**” (TNA) voice alert can be manually muted to reduce nuisance alerting. TNA muting status is shown in the upper right corner of the Traffic Map Page.

Muting the “TIS Not Available” voice alert:

- 1) Select the Traffic Map Page.
 - 2) Press the **TNA Mute** Softkey. The status is displayed in the upper left corner of the Traffic Map Page.
- Or:**
- a) Press the **MENU** Key.
 - b) Select “Not Available” Mute On’ (shown if TNA muting is currently off) and press the **ENT** Key.

SYSTEM STATUS

The system performs an automatic test of TIS during power-up. If TIS passes the test, TIS enters Standby Mode (on the ground) or Operating Mode (in the air). If TIS fails the power up test, an annunciation is shown in the center of the Traffic Map Page.

Traffic Map Page Center Banner Annunciation	Description
NO DATA	Data is not being received from the transponder*
DATA FAILED	Data is being received from the transponder, but a failure is detected in the data stream*
FAILED	The transponder has failed*
UNAVAILABLE	TIS is unavailable or out of range

* Contact a service center or Garmin dealer for corrective action

Table 6-15 TIS Failure Annunciations

The traffic mode is annunciated in the upper right corner of the Traffic Map Page. When the aircraft is on the ground, TIS automatically enters Standby Mode. If traffic is selected for display on another map while Standby Mode is selected, the traffic display enabled icon is crossed out (also the case whenever TIS has failed). Once the aircraft is airborne, TIS switches to Operating Mode and traffic information is displayed. The mode can be changed manually using softkeys or the page menu.

Traffic Map Mode Annunciation	Traffic Map Center Banner Annunciation	Traffic Overlay Status Icon (Navigation Maps)	Description
DATA FAILED	TRFC FAIL		Data is being received from the transponder, but a failure is detected in the data stream*
NO DATA	TRFC FAIL		Data is not being received from the transponder*
OPERATING	None		TIS is operating and is receiving traffic data from a data link.
OPERATING	UNAVAILABLE		TIS is operating, but the traffic service is currently unavailable or is out of reception range.
STANDBY	STANDBY		TIS is in Standby Mode.
UNIT FAILED	TRFC FAIL		The transponder has failed*

* Contact a service center or Garmin dealer for corrective action

Table 6-16 TIS Modes and Status Annunciations

Switching between TIS modes:

- 1) Select the Traffic Map Page.
- 2) Press the **Standby** or **Operate** Softkey to switch between modes. The mode is displayed in the upper right corner of the Traffic Map Page.

Or:

- a) Press the **MENU** Key.
- b) Select 'Operate Mode' or 'Standby Mode' (choice dependent on current state) and press the **ENT** Key.

The annunciations to indicate the status of traffic information appear in a banner at the lower left corner of maps on which traffic can be displayed, as shown in the following table.

Traffic Status Banner Annunciation	Description
TA OFF SCALE	A Traffic Advisory is outside the selected display range* Annunciation is removed when traffic comes within the selected display range
TA X.X ± XX ↓	System cannot determine bearing of Traffic Advisory** Annunciation indicates distance in nm, altitude separation in hundreds of feet, and altitude trend arrow (climbing/descending)
AGE MM:SS	Appears if traffic data is not refreshed within 6 seconds If after another 6 seconds data is not received, traffic is removed from the display The quality of displayed traffic information is reduced as the age increases
TRFC COAST	The displayed data is not current (6 to 12 seconds since last message) The quality of displayed traffic information is reduced when this message is displayed
TRFC RMVD	Traffic is removed because it is too old for coasting (12 to 60 seconds since last message) Traffic may exist within the selected display range, but it is not displayed
TRFC FAIL	Traffic data has failed
NO TRFC DATA	Traffic has not been detected
TRFC UNAVAIL	The traffic service is unavailable or out of range

*Shown as symbol on Traffic Map Page

**Shown in center of Traffic Map Page

Table 6-17 TIS Traffic Status Annunciations

6.5 TAS TRAFFIC



WARNING: Do not rely solely upon the display of traffic information for collision avoidance maneuvering. The traffic display does not provide collision avoidance resolution advisories and does not under any circumstances or conditions relieve the pilot's responsibility to see and avoid other aircraft.



WARNING: Do not rely solely upon the display of traffic information to accurately depict all of the traffic information within range of the aircraft. Due to lack of equipment, poor signal reception, and/or inaccurate information from other aircraft, traffic may be present but not represented on the display.



NOTE: Pilots should be aware of traffic system limitations. Traffic systems require transponders of other aircraft to respond to system interrogations. If the transponders do not respond to interrogations due to phenomena such as antenna shading or marginal transponder performance, traffic may be displayed intermittently, or not at all. Aircraft without altitude reporting capability are shown without altitude separation data or climb descent indication. Pilots should remain vigilant for traffic at all times.



NOTE: Mode-S TIS is disabled when another traffic system is installed.



NOTE: If Garmin GTX 345R transponder is installed, refer to the Automatic Dependent Surveillance-Broadcast (ADS-B) Traffic discussion for more information about ADS-B traffic displays.



NOTE: If an optional Honeywell KTA 870 TAS is installed, refer to the applicable Pilot's Guide from the manufacturer for detailed information about that traffic system.

The optional Garmin GTS 800 or Honeywell KTA 870 is a Traffic Advisory System (TAS). It enhances flight crew situational awareness by displaying traffic information for transponder-equipped aircraft. The system also provides visual annunciations and voice alerts to help the pilot visually acquire traffic.

The Garmin GTS 800 is capable of tracking up to 45 intruding aircraft equipped with Mode A or C transponders, and up to 30 intruding aircraft equipped with Mode S transponders. A maximum of 30 aircraft with the highest threat potential can be displayed simultaneously.

No TAS surveillance is provided for aircraft without operating transponders.

TAS THEORY OF OPERATION

When the traffic system is in Operating Mode, the system directly interrogates the transponders of other aircraft in the vicinity. The traffic system uses this information to derive the distance, relative bearing, and if reported, the altitude and vertical trend for each aircraft within its surveillance range. The traffic system then calculates a closure rate to each intruder based on the projected Closest Point of Approach (CPA). If the closure

rate meets the threat criteria for a Traffic Advisory (TA), the traffic system provides visual annunciations and voice alerts.

TAS SURVEILLANCE VOLUME AND SYMBOLOGY

The GTS 800 TAS surveillance system actively scans the airspace within $\pm 10,000$ feet of its altitude. Under ideal conditions, the GTS 800 scans transponder traffic up to 22 nm in the forward direction. The range is somewhat reduced to the sides and aft of the aircraft due to the directional interrogation signal patterns. In areas of greater transponder traffic density or when TCAS II (Traffic Alert and Collision Avoidance System II) systems are detected, the on-board traffic system automatically reduces its interrogation transmitter power (and therefore range) in order to limit potential interference from other signals.

If a Honeywell KTA 870 TAS is installed with a Garmin GTX 33 ES or GTX 330 transponder, the system uses the following symbols to represent traffic.

TAS Symbol	Description
	Non-Threat Traffic
	Proximity Advisory (PA)
	Traffic Advisory (TA)
	Traffic Advisory Off Scale

Table 6-18 TAS Symbol Description with GTX 335 Transponder

If a Garmin GTX 345 transponder is installed with the TAS, the symbols in the following table depict traffic, and include Automatic Dependent Surveillance-Broadcast (ADS-B) information. Refer to the ADS-B Traffic discussion later in this section for more information.

Symbol	Description
	Traffic Advisory with ADS-B directional information. Arrow points in the direction of the intruder aircraft track.
	Traffic Advisory without directional information.
	Traffic Advisory with ADS-B directional information is beyond the selected display range. Displayed at outer range ring at proper bearing. Arrow points in the direction of the intruder aircraft track.
	Traffic Advisory out of the selected display range without directional information. Displayed at outer range ring at proper bearing.
	Proximity Advisory with ADS-B directional information. Arrow points in the direction of the aircraft track.
	Proximity Advisory without directional information.
	Other Non-Threat traffic with ADS-B directional information. Arrow points in the direction of the intruder aircraft track.
	Other Non-Threat traffic without directional information.
	Traffic located on the ground with ADS-B directional information. Arrow points in the direction of the aircraft track. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.
	Ground traffic without ADS-B directional information. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.
	Non-aircraft ground traffic with ADS-B directional information. Pointed end indicates direction of travel. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.
	Non-aircraft ground traffic without ADS-B directional information. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.

Table 6-19 ADS-B Traffic Symbology with GTX 345R Transponder

A Traffic Advisory (TA), displayed as a solid amber circle or circle enclosing an arrow, alerts the crew to a potentially hazardous intruding aircraft, if the closing rate, distance, and vertical separation meet TA criteria. A TA that is beyond the selected display range (off scale) is indicated by a half TA symbol at the edge of the screen at the relative bearing of the intruder.

A Proximity Advisory (PA), displayed as a solid white diamond or arrow, indicates the intruding aircraft is within ±1200 feet and is within a 6 nm range, but is still not considered a TA threat.

Other, non-threat traffic, shown as an open white diamond or arrow, is displayed for traffic beyond six nautical miles that is neither a TA or PA.

Relative altitude, when available, is displayed above or below the corresponding intruder symbol in hundreds of feet. When this altitude is above own aircraft, it is preceded by a '+' symbol; a minus sign '-' indicates traffic is below own aircraft.

The system displays the altitude vertical trend as an up/down arrow (for speeds greater than 500 fpm in either direction) to the right of the intruder symbol.

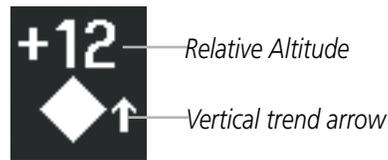


Figure 6-68 Intruder Altitude and Vertical Trend Arrow

TA ALERTING CONDITIONS (GTS 800)

The GTS 800 traffic system automatically adjusts its TA sensitivity level to reduce the likelihood of nuisance TA alerting when the aircraft is more likely to be near an airport. The system uses Level A (less) sensitivity when the height above terrain is at or below 2,000' AGL. If the height above terrain is unavailable, Level A sensitivity applies when the ground speed is less than 120 knots. In all other conditions, Level B (higher) sensitivity applies.

Sensitivity Level	Intruder Altitude Available	TA Alerting Conditions
A	Yes	Intruder closing rate provides less than 20 seconds of vertical and horizontal separation. Or: Intruder closing rate provides less than 20 seconds of horizontal separation and vertical separation is within 600 feet. Or: Intruder range is within 0.2 nm and vertical separation is within 600 feet.
A	No	Intruder closing rate provides less than 15 seconds of separation or intruder range is within 0.2 NM.
B	Yes	Intruder closing rate provides less than 30 seconds of vertical and horizontal separation. Or: Intruder closing rate provides less than 30 seconds of horizontal separation and vertical separation is within 800 feet. Or: Intruder range is within 0.55 nm and vertical separation is within 800 feet.
B	No	Intruder closing rate provides less than 20 seconds of separation or intruder range is within 0.55 NM.

Table 6-20 TA Sensitivity Level and TA Alerting Criteria

TAS ALERTS

NOTE: If an optional Honeywell KTA 870 TAS is installed, refer to the Pilot's Guide from the manufacturer for information about voice alerts for that traffic system.

When the GTS 800 detects a new TA, the following occur:

- The system issues a single **"Traffic!"** voice alert, followed by additional voice information about the bearing, relative altitude, and approximate distance from the intruder that triggered the TA. For example, the announcement **"Traffic! 12 o'clock, high, four miles,"** would indicate the traffic is in front of own aircraft, above own altitude, and approximately four nautical miles away.

Bearing	Relative Altitude	Approximate Distance (nm)
"One o'clock" through "Twelve o'clock" or "No Bearing"	"High", "Low", "Same Altitude" (if within 200 feet of own altitude), or "Altitude not available"	"Less than one mile", "One Mile" through "Ten Miles", or "More than ten miles"

Table 6-21 TA Descriptive Voice Announcements

- A TRAFFIC Annunciation appears at the right of the airspeed on the PFD, flashes for five seconds, and remains displayed until no TAs are detected in the area.
- A PFD map is automatically displayed with TA traffic.

If the bearing of TA traffic cannot be determined, a yellow text banner will be displayed in the center of the Traffic Map Page and in the lower-left of the PFD inset map instead of a TA symbol. The text will indicate "TA" followed by the distance, relative altitude, and vertical trend arrow for the TA traffic, if known.

A TA will be displayed for at least eight seconds, even if the condition(s) that initially triggered the TA are no longer present.

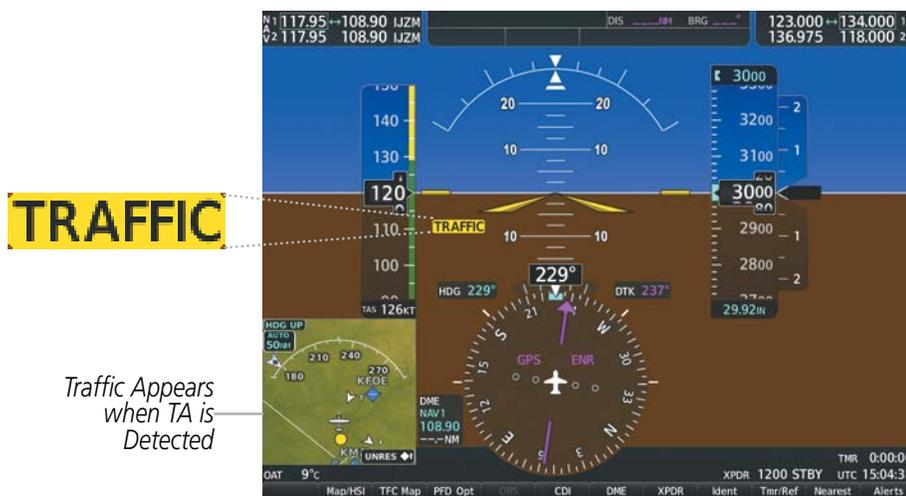


Figure 6-69 Traffic Annunciation (PFD)

SYSTEM TEST



NOTE: If an optional Honeywell KTA 870 TAS is installed, refer to the applicable Pilot's Guide from the manufacturer for information about applicable voice alerts for the system test.

The traffic system provides a system test mode to verify the TAS is operating normally. The test takes about ten seconds to complete. When the system test is initiated, a test pattern of traffic symbols appears on the Traffic Map Page. For the GTS 800, if system test passes, the system announces, “**TAS System Test Passed**” or “**TAS System Test Failed.**” When the system test is complete, the traffic system enters Standby Mode.

Testing the traffic system:

- 1) Turn the large **FMS** Knob to select the Map Page Group.
- 2) Turn the small **FMS** Knob to select the Traffic Map Page.
- 3) Turn the **Joystick** to set the range to 2/6 nm to allow for full test pattern to be displayed during test.
- 4) Press the **Standby** or **TAS STBY** Softkey.
- 5) Press the **Test** Softkey.

Or:

- 1) With the Traffic system in Standby mode, press the MENU Key.
- 2) Turn the small **FMS** Knob to select 'Test Mode'.
- 3) Press the **ENT** Key.



Figure 6-70 System Test in Progress with Test Pattern

OPERATION



NOTE: The Garmin GTS 800 TAS automatically changes from **Standby** to **Operating** mode eight seconds after takeoff. The system also automatically changes from **Operating** to **Standby** mode 24 seconds after landing.

When the avionics system initially receives power on the ground, the traffic system is in Standby Mode. The system must be in Operating Mode for traffic to be displayed and for TAs to be issued.

Changing traffic system modes on the Traffic Map Page:

- 1) Turn the large **FMS** Knob to select the Map Page Group.
- 2) Turn the small **FMS** Knob to select the Traffic Map Page.
- 3) Press the **Operate** or **TAS OPER** Softkey to begin displaying traffic. 'OPERATING' is displayed in the Traffic mode field.
- 4) Press the **Standby** or **TAS STBY** Softkey to place the system in the Standby mode. 'STANDBY' is displayed in the Traffic mode field.

Or:

- 1) With the Traffic Map Page displayed, press the **MENU** Key.
- 2) Turn the small **FMS** knob to highlight the desired mode.
- 3) Press the **ENT** Key.

TRAFFIC MAP PAGE

The Map - Traffic Map Page shows surrounding traffic data in relation to the aircraft's current position and altitude, without basemap clutter. It is the principal map page for viewing traffic information. Aircraft orientation is always heading up unless there is no valid heading. The pilot can adjust the map range with the **Joystick**. A range indication appears on each range ring.

The system annunciates the traffic mode and altitude display mode in the upper right corner of the Traffic Map Page.



Figure 6-71 Traffic Map Page

ALTITUDE DISPLAY MODE

The pilot can select the volume of airspace in which Other Non-Threat and Proximity Advisory traffic is displayed. If traffic meets the criteria for a TA, it is also displayed even if it is outside of the selected volume of airspace.

Changing the altitude range:

- 1) On the Traffic Map Page, select the **ALT Mode** Softkey.
- 2) Select one of the following Softkeys:
 - **Above:** Displays Other Non-Threat and Proximity Advisory traffic from 9900 feet above the aircraft to 2700 feet below the aircraft. Typically used during climb phase of flight.
 - **Normal:** Displays Other Non-Threat and Proximity Advisory traffic from 2700 feet above the aircraft to 2700 feet below the aircraft. Typically used during enroute phase of flight.
 - **Below:** Displays Other Non-Threat and Proximity Advisory traffic from 2700 feet above the aircraft to 9900 feet below the aircraft. Typically used during descent phase of flight.
 - **UNREST (unrestricted):** All traffic is displayed from 9900 feet above and 9900 feet below the aircraft.
- 3) To return to the Traffic Page, select the **Back** Softkey.

Or:

 - 1) Press the **MENU** Key.
 - 2) Turn the small **FMS** Knob to select one of the following (see softkey description in the previous step 2):
 - Above
 - Normal

- Below
 - Unrestricted
- 3) Select the **ENT** Softkey.

TRAFFIC MAP PAGE DISPLAY RANGE

The display range on the Traffic Map Page can be changed at any time. Map range is adjustable with the **Joystick**, and rings on the map denote the ranges.

Changing the display range on the Traffic Map Page:

- 1) Turn the **Joystick**.
- 2) The following range options are available:
 - 750 ft (with optional ADS-B)
 - 750 ft and 1500 ft (with optional ADS-B)
 - 1500 ft and 0.5 nm (with optional ADS-B)
 - 0.5 nm and 1 nm (with optional ADS-B)
 - 1 nm and 2 nm (with optional ADS-B)
 - 2 nm
 - 2 and 6 nm
 - 6 and 12 nm
 - 12 and 24 nm
 - 24 and 40 nm (available with ADS-B or KTA 870)

ADDITIONAL TRAFFIC DISPLAYS

The Map - Traffic Map Page is the principal map page for viewing traffic information. Traffic information can also be displayed on the following other maps for additional reference on the MFD when the traffic unit is operating:

- | | |
|-----------------------|---------------------------|
| • Navigation Map Page | • Nearest Pages |
| • Traffic Map Page | • Active Flight Plan Page |
| • Trip Planning Page | • Aux Video Page |

Enabling/disabling traffic information (MFD maps other than the Traffic Map Page):

- 1) Select the **Map Opt** Softkey.
- 2) Select the **Traffic** Softkey. Traffic is now displayed on the map.

When traffic is selected on maps other than the Traffic Map Page, the system shows a traffic status icon to indicate traffic is enabled for display as well as the altitude display mode (Above, Below, Normal, Unres).



Figure 6-72 TAS Traffic on Navigation Map

Customizing the traffic display on the Navigation Map Page:

- 1) Select the Navigation Map Page.
- 2) Press the **MENU** Key.
- 3) With 'Map Settings' highlighted, press the **ENT** Key.
- 4) Turn the small **FMS** Knob to select the Traffic Group and press the **ENT** Key.
- 5) Turn the large **FMS** Knob or press the **ENT** Key to scroll through the selections.
 - Traffic – Turns the display of traffic data on or off
 - Traffic Mode – Selects the traffic mode for display; select from:
 - All Traffic - Displays all traffic
 - TA/PA - Displays only Traffic Advisories and Proximity Advisories
 - TA Only - Displays Traffic Advisories only
 - Traffic Symbols – Selects the maximum range at which traffic symbols are shown
 - Traffic Labels – Selects the maximum range at which traffic labels (relative altitude, vertical trend) are shown with the option to turn off
- 6) Turn the small **FMS** Knob to scroll through options (On/Off, range settings, etc.).
- 7) Press the **ENT** Key to select an option.
- 8) Press the **FMS** Knob or **CLR** Key to return to the Navigation Map Page.

The Navigation Map Page Setup Menu also controls the display of traffic. The setup menu controls the map range settings. Traffic data symbols and labels can be decluttered from the display. If a map range larger than the map range setting is selected, the data is removed from the map. Maps besides the Traffic Map Page use settings based on those selected for the Navigation Map Page.

A traffic-only inset map is available on the PFD by pressing the **TFC Map** Softkey. A traffic map appears on the PFD. This map resembles the Traffic Map Page, and presents a heading up format. Traffic information can also be overlaid on PFD navigation maps.

Enabling/disabling traffic overlay on PFD navigation maps:

- 1) With the Inset Map or HSI Map displayed, press the **Map/HSI** Softkey on the PFD.
- 2) Press the **Traffic** Softkey to enable/disable the display traffic information.

SYSTEM STATUS

The traffic mode is annunciated in the upper right corner of the Traffic Map Page.

Mode	Traffic Mode Annunciation (Traffic Map Page)	Traffic Display Status Icon (Other Maps)
Traffic System Test Initiated	TEST (‘TEST MODE’ shown in center of page)	
Operating	OPERATING	
Standby	STANDBY (also shown in white in center of page)	
Traffic System Failed*	FAIL	

* See Table 6-23 for additional failure annunciations

Table 6-22 Traffic Modes

If the traffic unit fails, an annunciation as to the cause of the failure is shown in the center of the Traffic Map Page. During a failure condition, the Operating Mode cannot be selected.

Traffic Map Page Center Annunciation	Description
NO DATA	Data is not being received from the TAS unit
DATA FAILED	Data is being received from the TAS unit, but the unit is self-reporting a failure
FAILED	Incorrect data format received from the TAS unit

Table 6-23 TAS Failure Annunciations

The annunciations to indicate the status of traffic information appear in a banner at the lower left corner of maps on which traffic can be displayed.

Traffic Status Banner Annunciation	Description
TA OFF SCALE	A Traffic Advisory is outside the selected display range*. Annunciation is removed when traffic comes within the selected display range.
TA X.X ± XX ↓	System cannot determine bearing of Traffic Advisory**. Annunciation indicates distance in nm, altitude separation in hundreds of feet, and altitude trend arrow (climbing/descending).
TRFC FAIL	TAS unit has failed (unit is self-reporting a failure or sending incorrectly formatted data)
NO TRFC DATA	Data is not being received from the TAS unit

*Shown as symbol on Traffic Map Page

**Shown in center of Traffic Map Page

Table 6-24 TAS Traffic Status Annunciations

6.6 ADS-B TRAFFIC



WARNING: Do not rely solely upon the display of traffic information for collision avoidance maneuvering. The traffic display does not provide collision avoidance resolution advisories and does not under any circumstances or conditions relieve the pilot's responsibility to see and avoid other aircraft.



WARNING: Do not rely solely upon the display of traffic information to accurately depict all of the traffic information within range of the aircraft. Due to lack of equipment, poor signal reception, and/or inaccurate information from other aircraft, traffic may be present but not represented on the display.

ADS-B SYSTEM OVERVIEW

Automatic Dependent Surveillance-Broadcast (ADS-B) is a core technology in the FAA NextGen air traffic control system. It offers improved surveillance services, both air-to-air and air-to-ground, especially in areas where radar coverage is ineffective due to terrain, or where it is impractical or cost prohibitive. ADS-B is comprised of three segments for the purposes of providing traffic information: ADS-B (Broadcast), ADS-R (Rebroadcast), and Traffic Information Service-Broadcast (TIS-B).

ADS-B includes the automatic broadcast of position reports by aircraft, surface vehicles, and transmitters on fixed objects. These broadcasts contain information such as GPS position, identity (Flight ID, Call Sign, Tail Number, ICAO registration number, etc.), ground track, ground speed, pressure altitude, and emergency status.

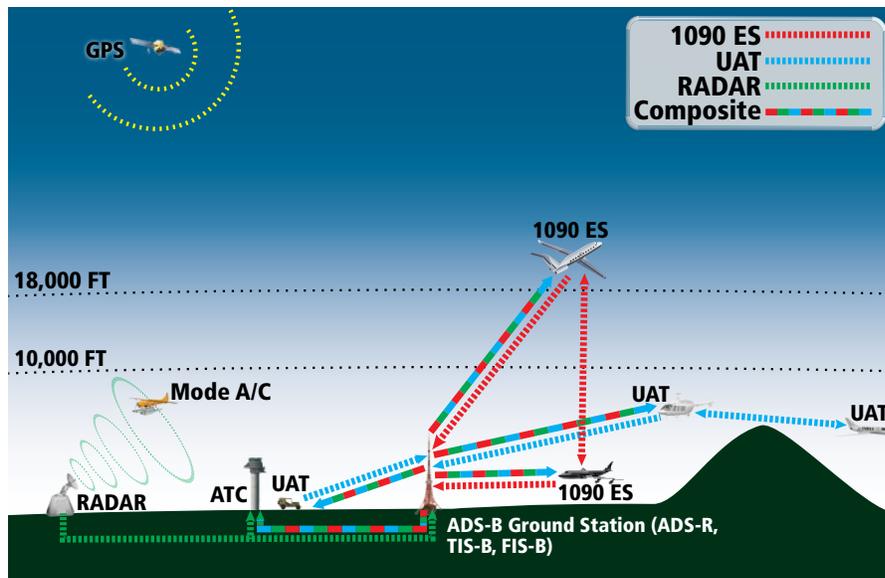


Figure 6-73 ADS-B System

For the purpose of distinguishing between levels of ADS-B service, there are three classifications of aircraft or system capability: ADS-B In, ADS-B Out, and ADS-B participating. ADS-B In refers to the capability to receive ADS-B information. ADS-B Out refers to the capability to transmit ADS-B information. ADS-B participating refers to the capability to both send and receive ADS-B information. Aircraft lacking either ADS-In, ADS-B Out, or both ADS-B capabilities may also be referred to as ADS-B nonparticipating aircraft.

The ADS-B system operates on two frequencies: 1090 MHz and 978 MHz. Both frequencies provide the same traffic information. An aircraft may be ADS-B In, Out, or participating on one or both frequencies, depending on the installed equipment. The 1090 MHz frequency portion of ADS-B is known as 1090 Extended Squitter (1090 ES). The 978 MHz portion of ADS-B is known as Universal Access Transceiver (UAT).

The optional Garmin GTX 33 ES/330 transponder provides ADS-B Out functions using the 1090 ES data link, and no ADS-B In traffic display is provided.

The optional Garmin GTX 345R transponder provides ADS-B Out functions using the 1090 ES data link. It also performs ADS-B In functions using the UAT data link. For the GTX 345, this includes the reception of Flight Information Services-Broadcast (FIS-B) data link weather service, provided when the aircraft is receiving data from a participating ground station; refer to the Data Link Weather section for more information about FIS-B Weather.

AUTOMATIC DEPENDENT SURVEILLANCE-REBROADCAST (ADS-R)

Because it is not required that ADS-B In capable aircraft be able to receive ADS-B data on both the 1090 MHz and 978 MHz data links, a method exists to get data from one data link to the other. ADS-R is the rebroadcast of ADS-B data by FAA ground stations, which provide this service by taking traffic data from one link and rebroadcasting it on the other. For example, if two aircraft are in the service volume for a ground station, and one is transmitting on 1090 MHz and the other is transmitting on 978 MHz, the ground station retransmits the data from each aircraft on the other link to ensure the two aircraft can “see” each other as traffic.

For example, if another aircraft can only receive 978 MHz UAT information, it cannot directly ‘see’ another aircraft sending only 1090 ES information aircraft unless an ADS-R ground station in the vicinity rebroadcasts the 1090 ES data over the 978 MHz UAT frequency. This is also true for an aircraft when can only receive 1090 ES data; it would need an ADS-R ground station to ‘see’ another aircraft operating on the UAT frequency.

TRAFFIC INFORMATION SERVICE-BROADCAST (TIS-B)

TIS-B provides a link between the secondary surveillance radar (SSR)-based system ATC uses and the ADS-B-based system. When an ADS-B In or Out capable aircraft is within the service volume of an FAA ADS-B ground station, the ground station broadcasts a portion of the ATC radar data to the aircraft. This aircraft is then included in the list of aircraft being provided TIS-B service and is then considered a “TIS-B participant.”

TIS-B coverage is available when the aircraft is within ground station coverage, in SSR coverage, and the other aircraft is also in SSR coverage, and is transmitting its altitude.

The ground station provides ATC radar information for other aircraft within $\pm 3,500$ feet and 15 NM of the participant, to include altitude, position, ground speed, and ground track. TIS-B broadcasts occur once every three to thirteen seconds, depending on the characteristics of the ground station providing the TIS-B service.

ADS-B WITH TAS

When the system is receiving ADS-B In traffic and with a Garmin GTS 800 TAS in Operating Mode, the system attempts to match (or “correlate”) data the two traffic sources. When a correlation is made, the system displays the traffic information for the tracked aircraft determined to be the most accurate. Any traffic that is not correlated (i.e., only detected by one system but not the other) is also displayed for the flight crew. This may occur, for example, if another aircraft is beyond the surveillance range of the TAS, but own aircraft is receiving information via ADS-B for the other aircraft. The traffic correlation feature improves the accuracy of the traffic displayed, while reducing the occurrence of displaying the same traffic for a given aircraft twice.



NOTE: When operating on the edges of ATC radar coverage or when using an optional active traffic system providing intermittent traffic data, a single aircraft may be briefly or periodically be depicted as two aircraft on the display.

CONFLICT SITUATIONAL AWARENESS & ALERTING (CSA)

Conflict Situational Awareness (CSA) is an alerting algorithm which provides ADS-B traffic alerting similar to the TAS system discussed previously.

When a TA occurs with is equipment, the displays a ‘TRAFFIC’ annunciation and provides a voice alert. This annunciation and voice alert is the same as the alerts issues by the Garmin GTS 800 TAS discussed previously.

The own aircraft altitude above terrain determines the sensitivity of the CSA algorithm to minimize nuisance alerts. Height Above Terrain, and Geodetic Sea Level (GSL) altitude are used to adjust the sensitivity of the CSA algorithm in accordance with the following table:

Sensitivity Level	Height Above Terrain (HAT)	GPS Phase of Flight	Own Altitude (Feet)	Look-ahead time (sec)	Vertical Threshold for Alert (feet)	Protected Volume (NM)
4	Any	Any	Any	20	850	0.20
4	Any	Any	Any	20	850	0.20
4	Unavailable	Approach	Any	20	850	0.20
5	Any	Any	Any	25	850	0.20
5	>1000 <=2350	Any	Any	25	850	0.20
5	Unavailable	Terminal	Any	25	850	0.20
6	Unavailable or >2350	Not approach and not Terminal (including unavailable)	<=5000	30	850	0.35
7	Unavailable or >2350	Not approach and not Terminal (including unavailable)	>5000 <=10,000	40	850	0.55
8	Unavailable or >2350	Not approach and not Terminal (including unavailable)	>10,000 <=20,000	45	850	0.80
9	Unavailable or >2350	Not approach and not Terminal (including unavailable)	>20,000 <=42,000	48	850	1.10
10	Unavailable or >2350	Not approach and not Terminal (including unavailable)	> 42,000	48	1200	1.10

Table 6-25 CSA Alerting Thresholds for ADS-B Traffic

AIRBORNE AND SURFACE APPLICATIONS

ADS-B traffic can help the pilot visually acquire traffic both in the air and on-the-ground. There are two ADS-B applications or modes: Airborne Situational Awareness (AIRB) and Surface Situational Awareness (SURF). The system automatically selects the appropriate application based on conditions.

The AIRB application is on when the aircraft is more than five NM and 1,500 feet above the nearest airport. When the AIRB application is active, the system only displays traffic which is airborne.

The SURF application is on when the aircraft is within five NM and less than 1,500 feet above field elevation. When the SURF application is on, the system displays airborne and on the ground traffic. At a Traffic Map Page range of one nm or less, the airport environment (including taxiways and runways) appears in addition to traffic. The airport displays are derived from the SafeTaxi database. Refer to the Additional Features section for more information about SafeTaxi displays.

NOTE: Do not rely on the solely on the traffic display to determine the runway alignment of traffic, especially when runways are in close proximity to each other.

Due to the varying precision of the data received via ADS-B, ADS-R, and TIS-B services, not all traffic symbols may not be depicted on the traffic display. Because higher data precision is required for traffic to be displayed in the SURF environment, some traffic eligible for AIRB will not be displayed while SURF is on. Availability for AIRB and SURF is depicted on the Aux - ADS-B Status Page, discussed later in this section.



Figure 6-74 Traffic Map Page with SURF Mode On

TRAFFIC DESCRIPTION

The symbols used to display ADS-B traffic are shown in the following table.

Symbol	Description
	Traffic Advisory with directional information. Points in the direction of the intruder aircraft track.
	Traffic Advisory without directional information.
	Traffic Advisory out of the selected display range with directional information. Displayed at outer range ring at proper bearing.
	Traffic Advisory out of the selected display range without directional information. Displayed at outer range ring at proper bearing.
	Proximity Advisory with directional information. Points in the direction of the aircraft track.
	Proximity Advisory without directional information.
	Other Non-Threat traffic with directional information. Points in the direction of the intruder aircraft track.
	Other Non-Threat traffic without directional information.
	Traffic located on the ground with directional information. Points in the direction of the aircraft track. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.
	Ground traffic without directional information. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.
	Non-aircraft ground traffic with ADS-B directional information. Pointed end indicates direction of travel. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.
	Non-aircraft ground traffic without ADS-B directional information. Ground traffic is only displayed when ADS-B is in Surface (SURF) Mode or own aircraft is on the ground.

Table 6-26 ADS-B Traffic Symbolology

OPERATION

TRAFFIC MAP PAGE

The Traffic Map Page shows surrounding traffic data in relation to the aircraft's current position and altitude, without basemap clutter. Aircraft orientation is always heading up unless there is no valid heading. Map range is adjustable with the **Joystick**, as indicated by the map range rings.

The traffic mode and altitude display mode are annunciated in the upper right corner of the page.



Figure 6-75 Traffic Map Page

Enabling/disabling the display of ADS-B traffic:

- 1) Select the Traffic Map Page.
- 2) Select the **ADS-B** Softkey.
 - Or:
 - a) Press the **MENU** Key and turn the small **FMS** Knob to highlight 'ADS-B On' or 'ADS-B Off'.
 - b) Press the **ENT** Key.

Testing the display of ADS-B traffic:

- 1) Select the Traffic Map Page.
- 2) If necessary, turn the Joystick to select a map range of 2 and 6 nm to ensure full test pattern display.
- 3) Ensure the **ADS-B** Softkey is disabled.
- 4) If the optional TAS is installed, ensure the **TAS STBY** Softkey is enabled.
- 5) Press the **Test** Softkey.
 - Or:
 - a) Press the **MENU** Key.
 - b) Turn the small **FMS** Knob to highlight 'Test Mode'.
 - c) Press the **ENT** Key.

A test pattern of traffic symbols appears during the test, and a 'TRAFFIC' annunciation appears on the PFD. At the conclusion of the test, the system issues the voice alert "Traffic System Test". If the test pattern is displayed and the voice alert is heard, the system has passed the test.



Figure 6-76 System Test in Progress with Test Pattern

The pilot can select the volume of airspace in which Other Non-Threat and Proximity traffic is displayed. TAs occurring outside of these limits will always be shown.

Changing the altitude range:

- 1) On the Traffic Map Page, select the **ALT Mode** Softkey.
 - 2) Select one of the following softkeys:
 - **Above:** Displays Other Non-Threat and proximity traffic from 9000 feet above the aircraft to 2700 feet below the aircraft. Typically used during climb phase of flight.
 - **Normal:** Displays Other Non-Threat and proximity traffic from 2700 feet above the aircraft to 2700 feet below the aircraft. Typically used during enroute phase of flight.
 - **Below:** Displays Other Non-Threat and proximity traffic from 2700 feet above the aircraft to 9000 feet below the aircraft. Typically used during descent phase of flight.
 - **UNREST** (unrestricted): All traffic is displayed from 9900 feet above and 9900 feet below the aircraft.
 - 3) To return to the Traffic Map Page, select the **Back** Softkey.
- Or:**
- 1) Press the **MENU** Key.

SYSTEM OVERVIEW

FLIGHT INSTRUMENTS

EIS

AUDIO PANEL & CNS

FLIGHT MANAGEMENT

HAZARD AVOIDANCE

AFCS

ADDITIONAL FEATURES

APPENDICES

INDEX

- 2) Turn the small **FMS** Knob to highlight one of the following options (see softkey description in the previous step 2):
 - Above
 - Normal
 - Below
 - Unrestricted
- 3) Press the **ENT** Key.

DISPLAYING MOTION VECTORS

When Absolute Motion Vectors are selected, the vectors extending from the traffic symbols depict the traffic's reported track and speed over the ground. When Relative Motion Vectors are selected, the vectors extending from the traffic symbols display how the traffic is moving relative to own aircraft. These vectors are calculated using the traffic's track and ground speed and own aircraft's track and ground speed. These two values are combined to depict where the traffic is moving purely with respect to own aircraft, and provide a forecast of where the traffic will be, relative to own aircraft, in the near future.

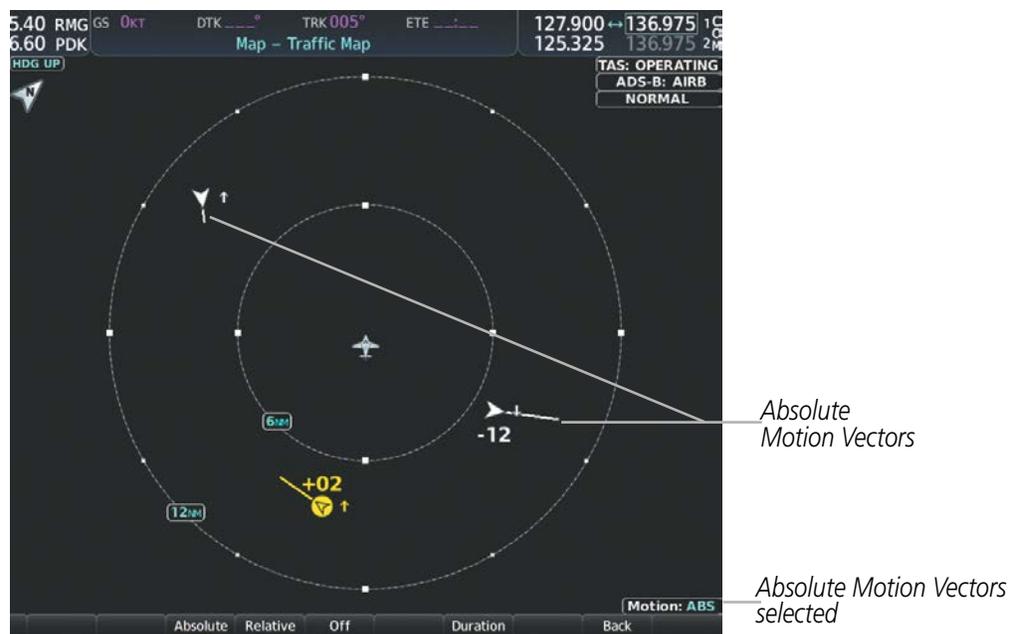


Figure 6-77 Traffic Map Page with Absolute Motion Vectors Enabled



Figure 6-78 Traffic Map Page with Relative Motion Vectors Enabled

Enabling/disabling the Motion Vector display:

- 1) Select the Traffic Map Page.
- 2) Select the **Motion** Softkey.
- 3) Select one of the following softkeys:
 - **Absolute:** Displays the motion vector pointing in the absolute direction.
 - **Relative:** Displays the motion vector relative to own aircraft
 - **Off:** Disables the display of the motion vector.

Or:

- 1) Select the Traffic Map Page.
- 2) Press the **MENU** Key.
- 3) Turn the small **FMS** Knob to highlight 'Relative Motion', 'Absolute Motion' or 'Motion Vector Off'.
- 4) Press the **ENT** Key.

Adjusting the duration for the Motion Vector projected time:

- 1) Select the Traffic Map Page.
- 2) Select the **Motion** Softkey.
- 3) Select the **Duration** Softkey.
- 4) Select a softkey for the desired duration (**30 SEC, 1 MIN, 2 MIN, 5 MIN**).
- 5) When finished, select the **Back** Softkey to return to the Traffic Map Page.

DISPLAYING ADDITIONAL TRAFFIC INFORMATION

The Traffic Map Page can display additional information for a selected aircraft symbol. This may include the aircraft tail number/Flight ID, type of aircraft (e.g., glider, small/medium/large aircraft, service vehicle, unmanned airborne vehicle (UAV), course, track, groundspeed), and other information.

Showing additional traffic information:

- 1) Select the Traffic Map Page.
- 2) Press the **FMS** Knob. A cyan border appears on the first selected traffic symbol. Additional information appears in a window in the lower-left corner of the Traffic Map Page.
- 3) To select a different aircraft symbol, turn the **FMS** Knob to move the cyan border until another symbol is selected.
- 4) When finished, press the **FMS** Knob again to disable the traffic selection.

TRAFFIC MAP PAGE DISPLAY RANGE

The display range on the Traffic Map Page can be changed at any time. Map range is adjustable with the **Joystick**, as indicated by the map range rings.

Changing the display range on the Traffic Map Page:

- 1) Turn the **Joystick**.
- 2) The following range options are available:
 - 500 feet
 - 500 feet and 1000 feet
 - 1000 feet and 2000 feet
 - 2000 feet and 1 nm
 - 1 and 2 nm
 - 2 and 6 nm
 - 6 and 12 nm
 - 12 and 24 nm
 - 24 and 40 nm



NOTE: ADS-B traffic can be displayed as an overlay to navigation maps. Refer to the previous TAS discussions for information about these additional traffic displays.

ADS-B SYSTEM STATUS

The traffic mode is annunciated in the upper right corner of the Traffic Map Page.

ADS-B Mode	Traffic Mode Annunciation (Traffic Map Page)	Traffic Map Page Center Banner Annunciation	Traffic Display Status Icon (Other Maps)
ADS-B System Test Initiated	ADS-B: TEST	TEST MODE	
ADS-B Operating in Airborne Mode	ADS-B: AIRB	None	
ADS-B Operating in Surface Mode	ADS-B: SURF	None	
ADS-B Traffic Off	ADS-B: OFF	ADS-B TRFC OFF	
ADS-B Traffic Not Available	ADS-B: N/A	ADS-B TRFC N/A	
ADS-B Failed*	ADS-B: FAIL	ADS-B TRFC FAIL	

* See Table 6-28 for additional failure annunciations

Table 6-27 ADS-B Modes



NOTE: If the optional TAS fails, the display of ADS-B traffic (ADS-B In) also fails, unless a GTX 345R transponder is installed. In this case, if the TAS fails, the display of ADS-B traffic continues even if the TAS has failed.

If the traffic unit fails, an annunciation as to the cause of the failure is shown in the center of the Traffic Map Page. During a failure condition, the Operating Mode cannot be selected.

Traffic Map Page Center Annunciation	Description
NO DATA	Data is not being received from the traffic unit
DATA FAILED	Data is being received from the traffic unit, but the unit is self-reporting a failure
FAILED	Incorrect data format received from the traffic unit

Table 6-28 Traffic Failure Annunciations

The annunciations to indicate the status of traffic information appear in a banner at the lower left corner of maps on which traffic can be displayed.

Traffic Status Banner Annunciation	Description
TA OFF SCALE	A Traffic Advisory is outside the selected display range*. Annunciation is removed when traffic comes within the selected display range.
TA X.X ± XX ↓	System cannot determine bearing of Traffic Advisory**. Annunciation indicates distance in nm, altitude separation in hundreds of feet, and altitude trend arrow (climbing/descending).
TRFC FAIL	Traffic unit has failed (unit is self-reporting a failure or sending incorrectly formatted data)
NO TRFC DATA	Data is not being received from the traffic unit

*Shown as symbol on Traffic Map Page

**Shown in center of Traffic Map Page

Table 6-29 Traffic Status Annunciations

Additional information about the status of ADS-B traffic products is available on the Aux - ADS-B Status Page.

Viewing ADS-B Traffic Status:

- 1) Turn the large **FMS** Knob to select the Aux Page Group.
- 2) Turn the small **FMS** Knob to select the Aux - ADS-B Status Page.



Figure 6-79 Viewing ADS-B Traffic Status on ADS-B Status Page

ADS-B Status Page Item	Status Message	Description
Traffic Application Status: Airborne (AIRB), Surface (SURF), Airborne Alerts (CSA)	On	Traffic application is currently on. Required input data is available, and it meets performance requirements.
	Available to Run	Traffic application is not currently active, but application is ready to run when condition(s) determine the application should be active. Required input data is available, and it meets performance requirements.
	Not Available	Traffic application is not available. Required input data is available, but it does not meet performance requirements.
	Fault	Traffic application is not available. Required input data is not available or the application has failed.
	Not Configured	Traffic application is not available, because it has not been configured. If this annunciation persists, the system should be serviced.
	-----	Traffic application status is invalid or unknown.
TIS-B/ADS-R Coverage	Available	The system is receiving the ADS-R coverage from an FAA ground station.
	Not Available	The system is not receiving the ADS-R coverage from an FAA ground station.
	-----	ADS-R coverage is invalid or unknown.
GPS Status: GPS Source	External #1	The system is using the #1 GPS receiver for the GPS position source.
	External #2	The system is using the #2 GPS receiver for the GPS position source.
	-----	The GPS source is invalid or unknown.
Ground Uplink Status: Last Uplink	Number of minutes, or '-----'	Displays the number of minutes since the last uplink from a ground station occurred. If no uplink has been received, or the status is invalid, dashes appear instead of the number of minutes.

Table 6-30 Aux-ADS-B Status Page Messages for ADS-B Traffic

SYSTEM
OVERVIEW

FLIGHT
INSTRUMENTS

EIS

AUDIO PANEL
& CNS

FLIGHT
MANAGEMENT

**HAZARD
AVOIDANCE**

AFCS

ADDITIONAL
FEATURES

APPENDICES

INDEX

BLANK PAGE

SECTION 7 AUTOMATIC FLIGHT CONTROL SYSTEM

7.1 AFCS OVERVIEW



NOTE: *The approved Pilot's Operating Handbook (POH).*

The Garmin AFCS is a digital Automatic Flight Control System (AFCS), fully integrated within the system avionics architecture. The System Overview section provides a block diagram to support this system description.

The Garmin AFCS can be divided into these main operating functions:

- **Flight Director (FD)** — Flight director operation takes place within the primary (#1) GIA 63W. Flight director commands are displayed on the PFD. The flight director provides:

The flight director provides:

- Command Bars showing pitch/roll guidance
 - Vertical/lateral mode selection and processing
 - Autopilot communication
- **Autopilot (AP)** — Autopilot operation occurs within the pitch, roll, and pitch trim servos. It also provides servo monitoring and automatic flight control in response to flight director steering commands, Attitude and Heading Reference System (AHRS) attitude and rate information, and airspeed.
 - **Yaw Damper (YD)** — The yaw servo is self-monitoring and provides Dutch roll damping and turn coordination in response to yaw rate, roll angle, lateral acceleration, and airspeed.
 - **Manual Electric Trim (MET)** — The pitch trim adapter provides manual electric trim capability when the autopilot is not engaged.

AFCS CONTROLS ON THE MFD

The following dedicated AFCS keys are located on the bezels of the PFD and MFD:

- ① **AP Key** Engages/disengages the autopilot
- ② **HDG Key** Selects/deselects Heading Select Mode
- ③ **NAV Key** Selects/deselects Navigation Mode
- ④ **APR Key** Selects/deselects Approach Mode
- ⑤ **VS Key** Selects/deselects Vertical Speed Mode
- ⑥ **FLC Key** Selects/deselects Flight Level Change Mode
- ⑦ **FD Key** Activates/deactivates the flight director only
 Pressing once turns on the flight director in the default pitch and roll modes. Pressing again deactivates the flight director and removes the Command Bars. If the autopilot is engaged, the key is disabled.
- ⑧ **ALT Key** Selects/deselects Altitude Hold Mode
- ⑨ **VNV Key** Selects/deselects Vertical Path Tracking Mode for Vertical Navigation flight control
- ⑩ **BC Key** Selects/deselects Backcourse Mode
- ⑪ **NOSE UP/NOSE DN Keys** Control the mode reference in Pitch Hold, Vertical Speed, and Flight Level Change modes

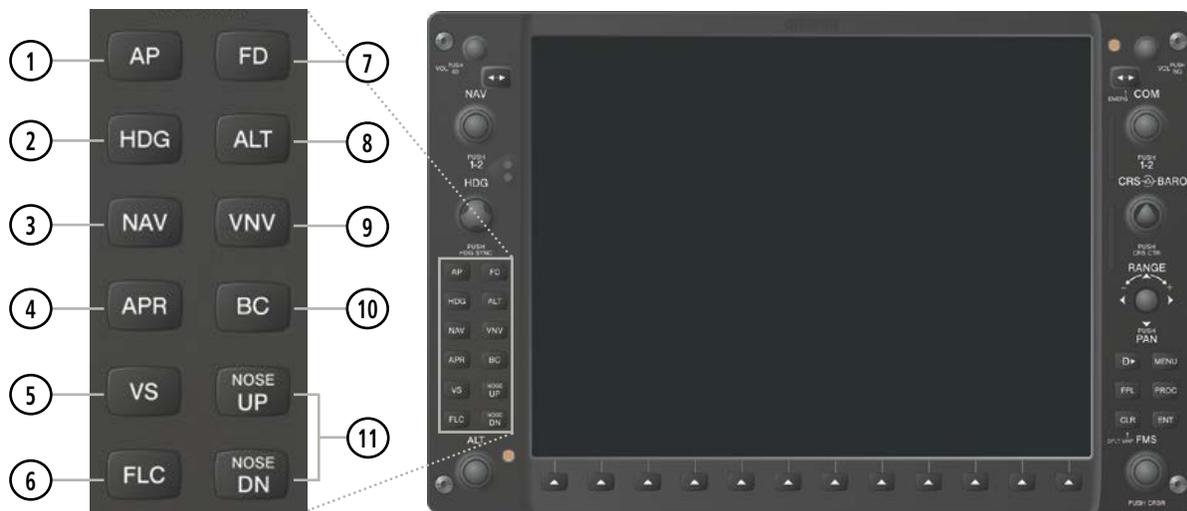


Figure 7-1 Dedicated AFCS Controls

The following AFCS controls are located in the cockpit separately from the PFD and MFD:

**AP DISC Switch
(Autopilot Disconnect)**

Disengages the autopilot and interrupts pitch trim operation

The **AP DISC** Switch is located on the pilot's control wheel.

This switch may be used to mute the aural autopilot disconnect alert.

**CWS Button
(Control Wheel Steering)**

While pressed, allows manual control of the aircraft while the autopilot is engaged and synchronizes the flight director's Command Bars with the current aircraft pitch (if not in Glideslope Mode) and roll (if in Roll Hold Mode)

Upon release of the **CWS** Button, the flight director may establish new reference points, depending on the current pitch and roll modes. CWS operation details are discussed in the flight director modes section.

The **CWS** Button is located on the pilot's control wheel.

GA Switch (Go Around)

Disengages the autopilot and selects flight director Go Around Mode

If an approach procedure is loaded this switch also activates the missed approach when the selected navigation source is GPS or when the navigation source is VOR/LOC and a valid frequency has been tuned.

The **GA** Switch is located on the instrument panel above the throttle.

MET Switch

(Manual Electric Trim)

Used to command manual electric trim

This composite switch is split into left and right sides. The left switch is the ARM contact and the right switch controls the DN (forward) and UP (rearward) contacts. The **MET** ARM Switch can be used to disengage the autopilot and to acknowledge an autopilot disconnect alert and mute the associated aural tone.

Manual trim commands are generated only when both sides of the switch are operated simultaneously. If either side of the switch is active separately for more than three seconds, MET function is disabled and 'PTRM' is displayed as the AFCS Status Annunciation on the PFD. The function remains disabled until both sides of the switch are inactivated.

The **MET** Switch is located on the pilot's control wheel.

BASIC AUTOPILOT OPERATION

The following describes basic autopilot functionality. A more detailed description follows in Section 7.4.

- **Autopilot Engagement** — The autopilot may be engaged by pushing the **AP Key** on the AFCS Control Unit. Annunciations regarding the engagement are indicated on the PFD.
- **Autopilot Engagement with Flight Director Off** — Upon engagement, the autopilot will be set to hold the current attitude of the airplane, if the flight director was not previously on. In this case, 'PIT' and 'ROL' will be annunciated.
- **Autopilot Engagement with Flight Director On** — If the flight director is on, the autopilot will smoothly pitch and roll the airplane to capture the FD command bars. The prior flight director modes remain unchanged.
- **Autopilot Disengagement** — The most common way to disconnect the autopilot is to press and release the **AP DISC Switch**, which is located on the control wheel. An autopilot disconnect tone will be heard and annunciated on the PFD. Other ways to disconnect the autopilot include:
 - Pressing the **AP Key** on the AFCS Control Unit
 - Pressing the **GA Switch** (located on the instrument panel above the throttle.)
 - Operating the **MET Switch** (located on the pilot's control wheel)
 - Pulling the autopilot circuit breaker

In the event of unexpected autopilot behavior, pressing and holding the **AP DISC Switch** will disconnect the autopilot and remove all power to the servos.

7.2 FLIGHT DIRECTOR OPERATION

The flight director function provides pitch and roll commands to the AFCS and displays them on the PFD. With the flight director activated, the aircraft can be hand-flown to follow the path shown by the Command Bars. Maximum commanded pitch (+20°/-15°) and roll (22°) angles, vertical acceleration, and roll rate are limited to values established during AFCS certification. The flight director also provides commands to the autopilot.

ACTIVATING THE FLIGHT DIRECTOR

An initial press of a key listed in Table 7-1 (when the flight director is not active) activates the flight director in the listed modes. The flight director may be turned off and the Command Bars removed from the display by pressing the **FD** Key again. The **FD** Key is disabled when the autopilot is engaged.

Control Pressed	Modes Selected			
	Lateral		Vertical	
FD Key	Roll Hold (default)	ROL	Pitch Hold (default)	PIT
AP Key	Roll Hold (default)	ROL	Pitch Hold (default)	PIT
CWS Button	Roll Hold (default)	ROL	Pitch Hold (default)	PIT
GA Switch	Takeoff (on ground)	TO	Takeoff (on ground)	TO
	Go Around (in air)	GA	Go Around (in air)	GA
ALT Key	Roll Hold (default)	ROL	Altitude Hold	ALT
VS Key	Roll Hold (default)	ROL	Vertical Speed	VS
VNV Key	Roll Hold (default)	ROL	Vertical Path Tracking*	VPTH
NAV Key	Navigation**	GPS	Pitch Hold (default)	PIT
		VOR		
		LOC		
BC Key	Backcourse***	BC	Pitch Hold (default)	PIT
APR Key	Approach**	GPS	Pitch Hold (default)	PIT
		VOR		
		LOC		
HDG Key	Heading Select	HDG	Pitch Hold (default)	PIT

*Valid VNV flight plan must be entered before **VNV** Key press activates flight director.

The selected navigation receiver must have a valid VOR or LOC signal or active GPS course before **NAV or **APR** Key press activates flight director.

***The selected navigation receiver must have a valid LOC signal before **BC** Key press activates flight director.

Table 7-1 Flight Director Activation

AFCS STATUS BOX

Flight director mode annunciations are displayed on the PFD when the flight director is active. Flight director selection and autopilot and yaw damper statuses are shown in the center of the AFCS Status Box. Lateral flight director modes are displayed on the left and vertical on the right. Armed modes are displayed in white and active in green.



Figure 7-2 PFD AFCS Display

FLIGHT DIRECTOR MODES

Flight director modes are normally selected independently for the pitch and roll axes. Unless otherwise specified, all mode keys are alternate action (i.e., press on, press off). In the absence of specific mode selection, the flight director reverts to the default pitch and/or roll modes.

Armed modes are annunciated in white and active in green in the AFCS Status Box. Under normal operation, when the control for the active flight director mode is pressed, the flight director reverts to the default mode(s) for the axis(es). Automatic transition from armed to active mode is indicated by the white armed mode annunciation moving to the green active mode field and flashing for 10 seconds.

If the information required to compute a flight director mode becomes invalid or unavailable, the flight director automatically reverts to the default mode for that axis. A flashing yellow mode annunciation and annunciator light indicate loss of sensor (ADC) or navigation data (VOR, LOC, GPS, VNV, SBAS) required to compute commands. When such a loss occurs, the system automatically begins to roll the wings level (enters Roll Hold Mode) or maintain the pitch angle (enters Pitch Hold Mode), depending on the affected axis. The flashing annunciation stops when the affected mode key is pressed or another mode for the axis is selected. If after 10 seconds no action is taken, the flashing annunciation stops.



Figure 7-3 Loss of GPS Signal

The flight director is automatically disabled if the attitude information required to compute the default flight director modes becomes invalid or unavailable.

COMMAND BARS

Upon activation of the flight director, Command Bars are displayed in magenta on the PFD as a single cue. The Command Bars do not override the Aircraft Symbol. The Command Bars move together vertically to indicate pitch commands and bank left or right to indicate roll commands.

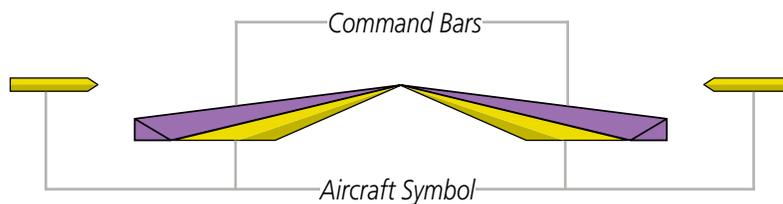


Figure 7-4 Command Bars

If the attitude information being sent to the flight director becomes invalid or unavailable, the Command Bars are removed from the display. The flight director Command Bars also disappear if the pitch exceeds +30°/-20° or bank exceeds 65°.

7.3 AFCS MODES

The AFCS is capable of operating in a variety of independent Lateral Modes, Vertical Modes and Combination of both the Lateral and Vertical Modes.

VERTICAL MODES

The following table lists the vertical modes with their corresponding controls and annunciations. The mode reference is displayed next to the active mode annunciation for Altitude Hold, Vertical Speed, and Flight Level Change modes. The **NOSE UP/DN** Wheel can be used to change the vertical mode reference while operating under Pitch Hold, Vertical Speed, or Flight Level Change Mode.

Vertical Mode	Description	Control	Annunciation	Reference Range	Reference Change Increment
Pitch Hold	Holds the current aircraft pitch attitude; may be used to climb/descend to the Selected Altitude	(default)	PIT	-15° to +20°	0.5°
Selected Altitude Capture	Captures the Selected Altitude	*	ALTS		
Altitude Hold	Holds the current Altitude Reference	ALT Key	ALT nnnnn FT		
Vertical Speed	Maintains the current aircraft vertical speed; may be used to climb/descend to the Selected Altitude	VS Key	VS nnnn FPM	-2000 to +1500 fpm	100 fpm
Flight Level Change, IAS Hold	Maintains the current aircraft airspeed in IAS while the aircraft is climbing/descending to the Selected Altitude	FLC Key	FLC nnn KT	80 to 200 kts (350) 80 to 210 kts (400)	1 kt

* *ALTS armed automatically when PIT, VS, FLC, TO, or GA active, and under VPTH when Selected Altitude is to be captured instead of VNV Target Altitude*

Table 7-2 Flight Director Vertical Modes

PITCH HOLD MODE (PIT)

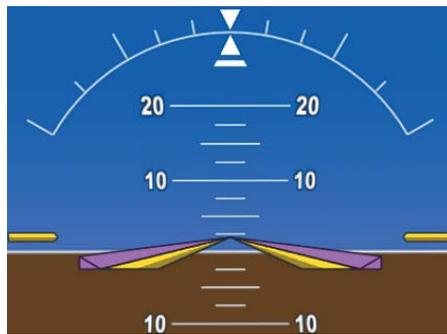
When the flight director is activated (the **FD** Key is pressed), Pitch Hold Mode is selected by default. Pitch Hold Mode is indicated as the active vertical mode by the green ‘PIT’ annunciation. This mode may be used for climb or descent to the Selected Altitude (shown above the Altimeter), since Selected Altitude Capture Mode is automatically armed when Pitch Hold Mode is activated.

In Pitch Hold Mode, the flight director maintains a constant pitch attitude, the pitch reference. The pitch reference is set to the aircraft pitch attitude at the moment of mode selection. If the aircraft pitch attitude exceeds the flight director pitch command limitations, the flight director commands a pitch angle equal to the nose-up/down limit.

CHANGING THE PITCH REFERENCE

When operating in Pitch Hold Mode, the pitch reference can be adjusted by:

- Using the **NOSE UP/NOSE DN** Keys
- Pressing the **CWS** Switch, hand-flying the aircraft to establish a new pitch reference, then releasing the **CWS** Switch



Command Bars Maintain Desired Pitch Reference

Figure 7-5 Pitch Hold Mode

SELECTED ALTITUDE CAPTURE MODE (ALTS)

Selected Altitude Capture Mode is automatically armed with activation of the following modes:

- Pitch Hold
- Vertical Speed
- Flight Level Change
- Go Around
- Vertical Path Tracking (if the Selected Altitude is to be captured instead of the VNV Target Altitude)

The white 'ALTS' annunciation indicates Selected Altitude Capture Mode is armed. The **ALT** Knob is used to set the Selected Altitude (shown above the Altimeter) until Selected Altitude Capture Mode becomes active.

As the aircraft nears the Selected Altitude, the flight director automatically transitions to Selected Altitude Capture Mode with Altitude Hold Mode armed. This automatic transition is indicated by the green 'ALTS' annunciation flashing for up to 10 seconds and the appearance of the white 'ALT' annunciation. The Selected Altitude is shown as the Altitude Reference beside the 'ALTS' annunciation.

At 50 feet from the Selected Altitude, the flight director automatically transitions from Selected Altitude Capture to Altitude Hold Mode and holds the Selected Altitude (shown as the Altitude Reference). As Altitude Hold Mode becomes active, the white 'ALT' annunciation moves to the active vertical mode field and flashes green for 10 seconds to indicate the automatic transition.

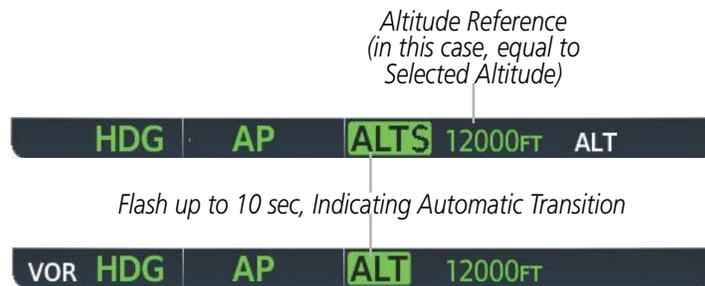


Figure 7-6 Automatic Mode Transitions During Altitude Capture

CHANGING THE SELECTED ALTITUDE



NOTE: Pressing the **CWS** Switch while in Selected Altitude Capture Mode does not cancel the mode.

Use of the **ALT** Knob to change the Selected Altitude while Selected Altitude Capture Mode is active causes the flight director to revert to Pitch Hold Mode with Selected Altitude Capture Mode armed for the new Selected Altitude.

ALTITUDE HOLD MODE (ALT)

Altitude Hold Mode can be activated by pressing the **ALT** Key; the flight director maintains the current aircraft altitude (to the nearest 10 feet) as the Altitude Reference. The flight director's Altitude Reference, shown in the AFCS Status Box, is independent of the Selected Altitude, displayed above the Altimeter. Altitude Hold Mode active is indicated by a green 'ALT' annunciation in the AFCS Status Box.

Altitude Hold Mode is automatically armed when the flight director is in Selected Altitude Capture Mode. Selected Altitude Capture Mode automatically transitions to Altitude Hold Mode when the altitude error is less than 50 feet. In this case, the Selected Altitude becomes the flight director's Altitude Reference.

CHANGING THE ALTITUDE REFERENCE



NOTE: Turning the **ALT** Knob while in Altitude Hold Mode changes the Selected Altitude, but not the flight director's Altitude Reference, and does not cancel the mode.

The Altitude Reference (shown in the AFCS Status Box) may be changed by:

- Using the **NOSE UP/NOSE DN** Keys
- Pressing the **CWS** Switch, hand-flying the aircraft to attain a new Altitude Reference, then releasing the **CWS** Switch at the desired altitude (the new altitude is now the Altitude Reference)

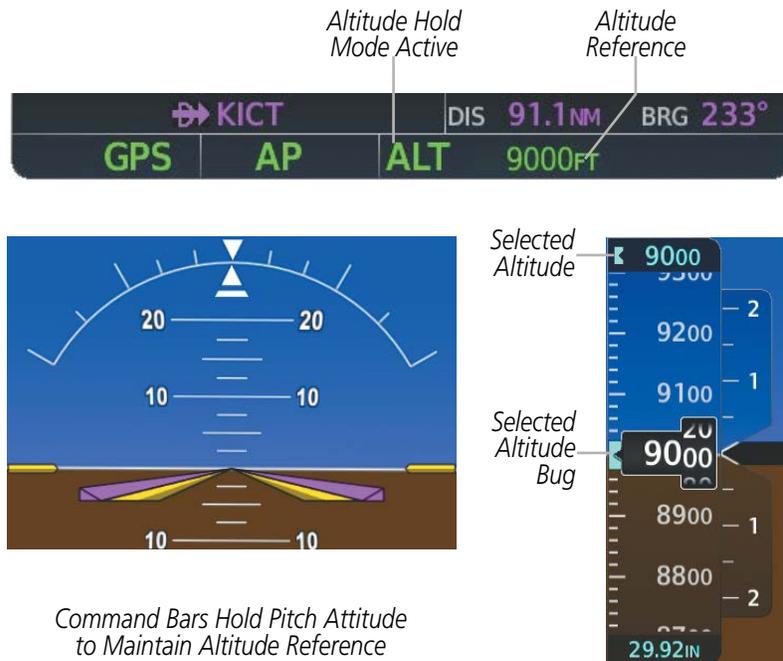


Figure 7-7 Altitude Hold Mode

VERTICAL SPEED MODE (VS)

In Vertical Speed Mode, the flight director acquires and maintains a Vertical Speed Reference. Current aircraft vertical speed (to the nearest 100 fpm) becomes the Vertical Speed Reference at the moment of Vertical Speed Mode activation. This mode may be used for climb or descent to the Selected Altitude (shown above the Altimeter) since Selected Altitude Capture Mode is automatically armed when Vertical Speed Mode is selected.

When Vertical Speed Mode is activated by pressing the **VS** Key, 'VS' is annunciated in green in the AFCS Status Box along with the Vertical Speed Reference. The Vertical Speed Reference is also displayed above the Vertical Speed Indicator. A Vertical Speed Reference Bug corresponding to the Vertical Speed Reference is shown on the indicator.

CHANGING THE VERTICAL SPEED REFERENCE

The Vertical Speed Reference (shown both in the AFCS Status Box and above the Vertical Speed Indicator) may be changed by:

- Using the **NOSE UP/NOSE DN** Keys
- Pressing the **CWS** Switch, hand-flying the aircraft to attain a new Vertical Speed Reference, then releasing the **CWS** Switch



NOTE: If the Selected Altitude is reached during CWS maneuvering, the Altitude Reference is not changed. To adjust the Altitude Reference in this case, the **CWS** Switch must be pressed again after the Selected Altitude is reached.

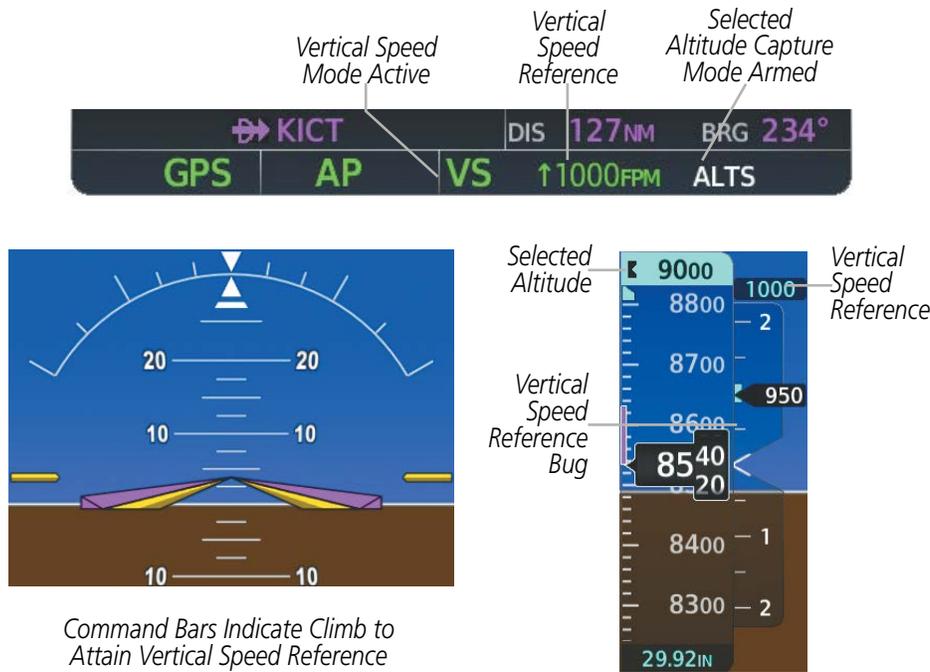


Figure 7-8 Vertical Speed Hold Mode

FLIGHT LEVEL CHANGE MODE (FLC)

NOTE: *The Selected Altitude should be set before selecting Flight Level Change Mode.*

Flight Level Change Mode is selected by pressing the **FLC** Key. This mode acquires and maintains the Airspeed Reference (IAS) while climbing or descending to the Selected Altitude (shown above the Altimeter). When Flight Level Change Mode is active, the flight director continuously monitors Selected Altitude, airspeed and altitude.

The Airspeed Reference is set to the current airspeed upon mode activation. Flight Level Change Mode is indicated by a green 'FLC' annunciation beside the Airspeed Reference in the AFCS Status Box. The Airspeed Reference is also displayed directly above the Airspeed Indicator, along with a bug corresponding to the Airspeed Reference along the tape.

Engine power must be adjusted to allow the autopilot to fly the aircraft at a pitch attitude corresponding to the desired flight profile (climb or descent) while maintaining the Airspeed Reference. The flight director maintains the current altitude until either engine power or the Airspeed Reference are adjusted and does not allow the aircraft to climb or descend away from the Selected Altitude.

CHANGING THE AIRSPEED REFERENCE

The Airspeed Reference (shown in both the AFCS Status Box and above the Airspeed Indicator) may be adjusted by:

- Using the **NOSE UP/NOSE DN** Keys
- Pressing the **CWS** Switch, hand-flying the aircraft to attain a new Airspeed Reference, then releasing the **CWS** Switch

NOTE: *If the Selected Altitude is reached during CWS maneuvering, the Airspeed Reference is not changed. To adjust the Airspeed Reference in this case, the CWS Switch must be pressed again after the Selected Altitude is reached.*

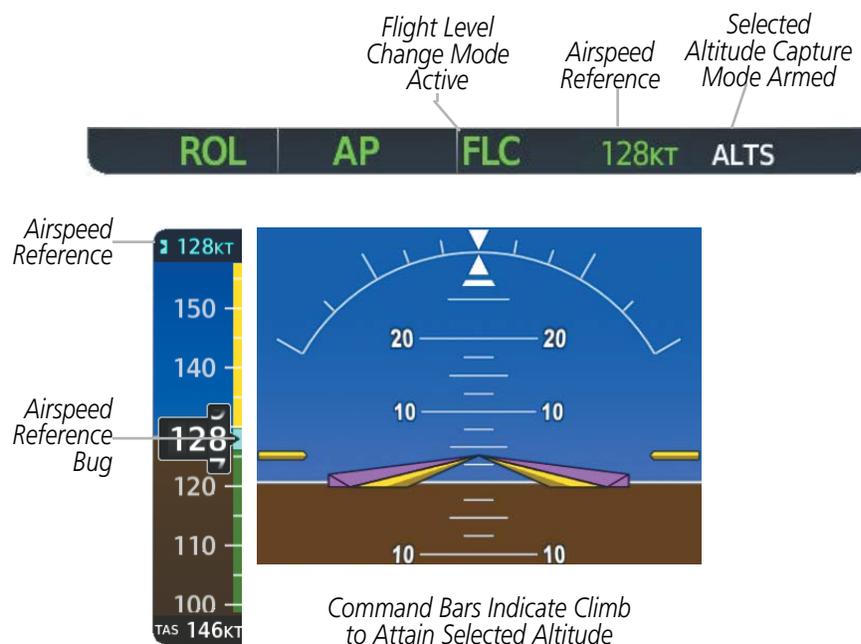


Figure 7-9 Flight Level Change Mode (IAS)

LATERAL MODES

The following table relates each Garmin AFCS lateral mode to its respective control and annunciation. Refer to the combination modes section for information regarding Go Around and Takeoff modes.

Lateral Mode	Description	Control	Annunciation	Maximum Roll Command Limit
Roll Hold	Holds the current aircraft roll attitude or rolls the wings level, depending on the commanded bank angle	(default)	ROL	22°
Heading Select	Captures and tracks the Selected Heading	HDG Key	HDG	22°
Navigation, GPS Arm/Capture/Track	Captures and tracks the selected navigation source (GPS, VOR, LOC)	NAV Key	GPS	22° Capture 10° Track
Navigation, VOR Enroute Arm/Capture/Track			VOR	22° Capture 10° Track
Navigation, LOC Arm/Capture/Track (No Glideslope)			LOC	22° Capture 10° Track

* No annunciation appears in the AFCS Status Box. The acceptable bank angle range is indicated in green along the Roll Scale of the Attitude Indicator.

Table 7-3 Flight Director Lateral Modes

The **CWS** Button does not change lateral references for Heading Select, Navigation, Backcourse, or Approach Mode. The autopilot guides the aircraft back to the Selected Heading/Course upon release of the **CWS** Button.

ROLL HOLD MODE (ROL)



NOTE: If Roll Hold Mode is activated as a result of a mode reversion, the flight director rolls the wings level.

When the flight director is activated or switched, Roll Hold Mode is selected by default. This mode is annunciated as ‘ROL’ in the AFCS Status Box. The current aircraft bank angle is held, subject to the bank angle condition.



Figure 7-10 Roll Hold Mode Annunciation

Bank Angle	Flight Director Response
< 6°	Rolls wings level
6 to 22°	Maintains current aircraft roll attitude
> 22°	Limits bank to 22°

Table 7-4 Roll Hold Mode Responses

CHANGING THE ROLL REFERENCE

The roll reference can be changed by pressing the **CWS** Switch, establishing the desired bank angle, then releasing the **CWS** Switch.

HEADING SELECT MODE (HDG)

Heading Select Mode is activated by pressing the **HDG** Key. Heading Select Mode acquires and maintains the Selected Heading. The Selected Heading is shown by a light blue bug on the HSI.

CHANGING THE SELECTED HEADING



NOTE: Pressing the **HDG** Knob synchronizes the Selected Heading to the current heading.

The Selected Heading is adjusted using the **HDG** Knob. Pressing the **CWS** Switch and hand-flying the aircraft does not change the Selected Heading. The autopilot guides the aircraft back to the Selected Heading upon release of the **CWS** Switch.

Turns are commanded in the same direction as Selected Heading Bug movement, even if the bug is turned more than 180° from the present heading (e.g., a 270° turn to the right). However, Selected Heading changes of more than 330° at a time result in turn reversals.

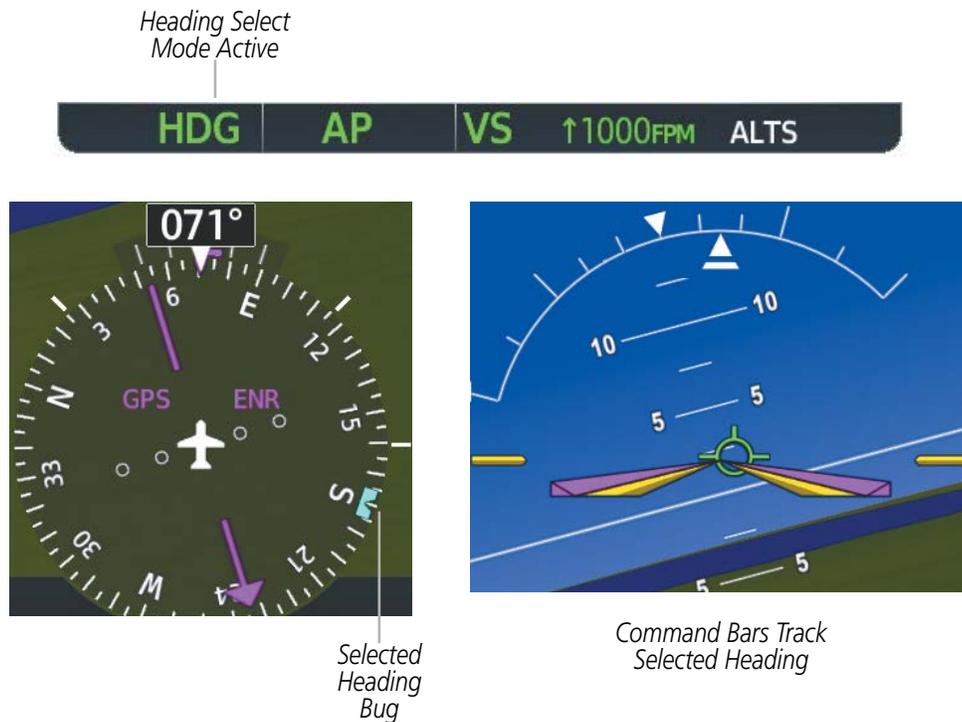


Figure 7-11 Heading Select Mode

NAVIGATION MODES (GPS, VOR, LOC)

NOTE: The selected navigation receiver must have a valid VOR or LOC signal or active GPS course for the flight director to enter Navigation Mode.

NOTE: When intercepting a flight plan leg, the flight director gives commands to capture the active leg at approximately a 45° angle to the track between the waypoints defining the active leg. The flight director does not give commands to fly to the starting waypoint of the active leg.

NOTE: When making a backcourse approach, set the Selected Course to the localizer front course.

Pressing the **NAV** Key selects Navigation Mode. Navigation Mode acquires and tracks the selected navigation source (GPS, VOR, LOC). The flight director follows GPS roll steering commands when GPS is the selected navigation source. When the navigation source is VOR or LOC, the flight director creates roll steering commands from the Selected Course and deviation. Navigation Mode can also be used to fly GPS and LOC approaches where vertical guidance is not required.

Backcourse Mode captures and tracks a localizer signal in the backcourse direction. The mode may be selected by pressing the **BC** Key. Backcourse Mode is armed if the CDI is greater than one dot when the mode is selected. If the CDI is less than one dot, the Backcourse Mode is automatically captured when the **BC** Key is pressed. The flight director creates roll steering commands from the Selected Course and deviation when in Backcourse Mode.

If the Course Deviation Indicator (CDI) shows greater than one dot when the **NAV** or **BC** Key is pressed, the selected mode is armed. If the CDI shows less than one dot, Navigation Mode is automatically captured when the **NAV** or **BC** Key is pressed. The armed annunciation appears in white to the left of the active lateral mode.



Figure 7-12 GPS Navigation Mode Armed

When the CDI has automatically switched from GPS to LOC during a LOC/ILS approach, GPS Navigation Mode remains active, providing GPS steering guidance until the localizer signal is captured. LOC Navigation Mode is armed automatically when the navigation source switch takes place if the **APR** Key is not pressed prior to the automatic source switch.

If Navigation Mode is active and either of the following occur, the flight director reverts to Roll Hold Mode (wings rolled level):

- Different VOR tuned while in VOR Navigation Mode (VOR Navigation Mode reverts to armed)
- Navigation source manually switched (with the **CDI** Softkey)
- During a LOC/ILS approach, the FAF is crossed while in GPS Navigation Mode after the automatic navigation source switch from GPS to LOC

CHANGING THE SELECTED COURSE

If the navigation source is VOR or localizer, or OBS Mode has been enabled when using GPS, the Selected Course is controlled using the **CRS** Knob.

Pressing the **CWS** Switch and hand-flying the aircraft does not change the Selected Course while in Navigation Mode. The autopilot guides the aircraft back to the Selected Course (or GPS flight plan) when the **CWS** Switch is released.

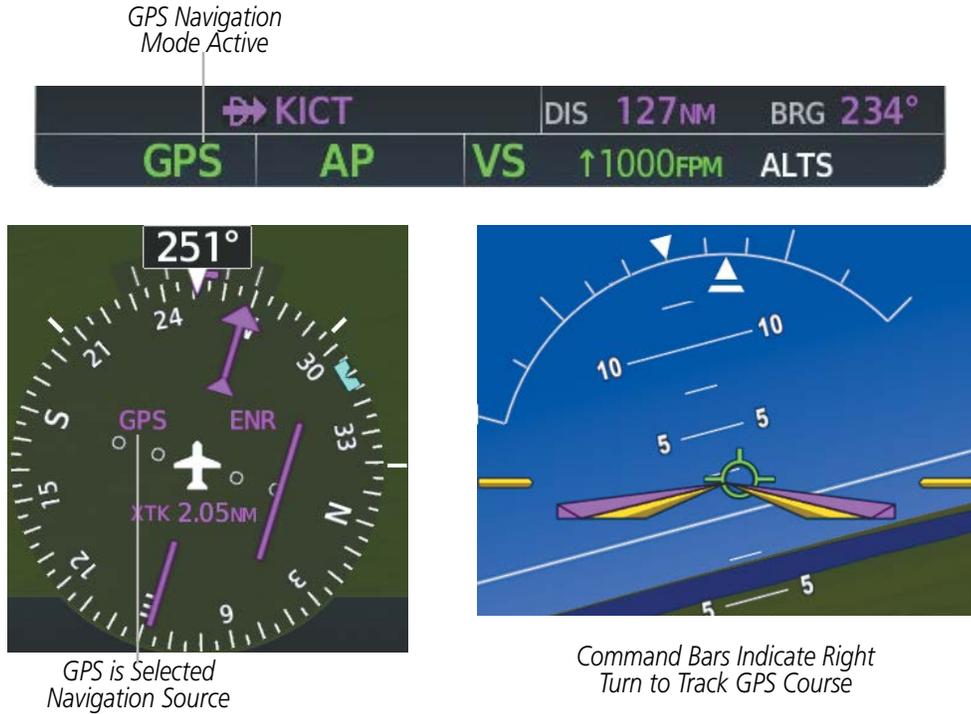


Figure 7-13 Navigation Mode

SYSTEM OVERVIEW

FLIGHT INSTRUMENTS

EIS

AUDIO PANEL & CNS

FLIGHT MANAGEMENT

HAZARD AVOIDANCE

AFCS

ADDITIONAL FEATURES

APPENDICES

INDEX

COMBINATION MODES (VNV, APR, NAV, BC, GA)

The following table lists the modes that operating by using both Vertical and Lateral Modes with their corresponding controls and annunciations.

Mode	Description	Control	Annunciation	Maximum Roll Command Limit	Reference Range
Vertical Path Tracking	Captures and tracks descent legs of an active vertical profile	VNV Key	VPTH		
VNV Target Altitude Capture	Captures the Vertical Navigation (VNV) Target Altitude	*	ALTV		
Glidepath	Captures and tracks the SBAS glidepath on approach	APR Key	GP		
Glideslope	Captures and tracks the ILS glideslope on approach		GS		
Backcourse Arm/Capture/Track	Captures and tracks a localizer signal for backcourse approaches	BC Key	BC	22° Capture 10° Track	
Approach, GPS Arm/Capture/Track	Captures and tracks the selected navigation source (GPS, VOR, LOC)	APR Key	GPS	22° Capture 10° Track	
Approach, VOR Arm/Capture/Track			VAPP	22° Capture 10° Track	
Approach, ILS Arm/Capture/Track (Glideslope Mode automatically armed)			LOC	22° Capture 10° Track	
Go Around**	Commands a constant pitch angle and wings level in the air	GA Button	GA		7°

* ALTV is armed automatically under VPTH when VNV Target Altitude is to be captured instead of Selected Altitude.

**Go Around mode disengages the autopilot unless a compatible lift computer is installed.

Table 7-5 Flight Director Combination Modes

SYSTEM OVERVIEW

FLIGHT INSTRUMENTS

EIS

AUDIO PANEL & CNS

FLIGHT MANAGEMENT

HAZARD AVOIDANCE

AFCS

ADDITIONAL FEATURES

APPENDICES

INDEX

VERTICAL NAVIGATION MODES (VPTH, ALTV)

 **NOTE:** VNV is disabled when parallel track or Dead Reckoning Mode is active.

 **NOTE:** The Selected Altitude takes precedence over any other vertical constraints.

Vertical Navigation (VNV) flight control is available for enroute/terminal cruise and descent operations any time that VNV flight planning is available. Refer to the Flight Management Section for more information on VNV flight plans. Conditions for availability include, but are not limited to:

- The selected navigation source is GPS.
- A VNV flight plan (with at least one altitude-constrained waypoint) or vertical direct-to is active.
- VNV is enabled (**VNV ENBL** Softkey pressed on the MFD).
- Crosstrack error is valid and within certain limits.
- Desired/actual track are valid or track angle error is within certain limits.
- The VNV Target Altitude of the active waypoint is no more than 250 ft above the current aircraft altitude.

The flight director may be armed for VNV at any time, but no target altitudes are captured during a climb. The Command Bars provide vertical profile guidance based on specified altitudes (entered manually or loaded from the database) at waypoints in the active flight plan or vertical direct-to. The appropriate VNV flight control modes are sequenced by the flight director to follow the path defined by the vertical profile. Upon reaching the last waypoint in the VNV flight plan, the flight director transitions to Altitude Hold Mode and cancels any armed VNV modes.

VERTICAL PATH TRACKING MODE (VPTH)

 **NOTE:** Vertical Path Tracking Mode is only applicable to aircraft equipped with a **VNV** Key.

 **NOTE:** If another vertical mode key is pressed while Vertical Path Tracking Mode is selected, Vertical Path Tracking Mode reverts to armed.

 **NOTE:** Pressing the **CWS** Switch while Vertical Path Tracking Mode is active does not cancel the mode. The autopilot guides the aircraft back to the descent path upon release of the **CWS** Switch.

When a vertical profile (VNV flight plan) is active and the **VNV** Key is pressed, Vertical Path Tracking Mode is armed in preparation for descent path capture. ‘VPTH’ (or ‘/V’ when Glidepath or Glideslope Mode is concurrently armed) is annunciated in white in addition to previously armed modes. If applicable, the appropriate altitude capture mode is armed for capture of the next VNV Target Altitude (ALTV) or the Selected Altitude (ALTS), whichever is greater.

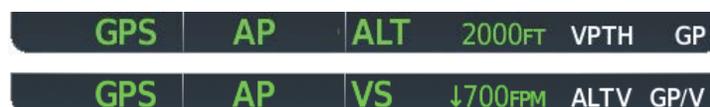


Figure 7-14 Vertical Path Tracking Armed Annunciations

- SYSTEM OVERVIEW
- FLIGHT INSTRUMENTS
- EIS
- AUDIO PANEL & CNS
- FLIGHT MANAGEMENT
- HAZARD AVOIDANCE
- AFCS
- ADDITIONAL FEATURES
- APPENDICES
- INDEX

Prior to descent path interception, the Selected Altitude must be set below the current aircraft altitude by at least 75 feet. For the flight director to transition from Altitude Hold to Vertical Path Tracking Mode, acknowledgment is required within five minutes of descent path interception by:

- Pressing the **VNV** Key
- Adjusting the Selected Altitude

If acknowledgment is not received within one minute of descent path interception, the white ‘VPTH’ annunciation starts to flash. Flashing continues until acknowledged or the descent path is intercepted. If the descent is not confirmed by the time of interception, Vertical Path Tracking Mode remains armed and the descent is not captured.

In conjunction with the “TOD [top of descent] within 1 minute” annunciation in the PFD Navigation Status Box and the “Vertical track” voice message, VNV indications (VNV Target Altitude, vertical deviation, and vertical speed required) appear on the PFD in magenta.

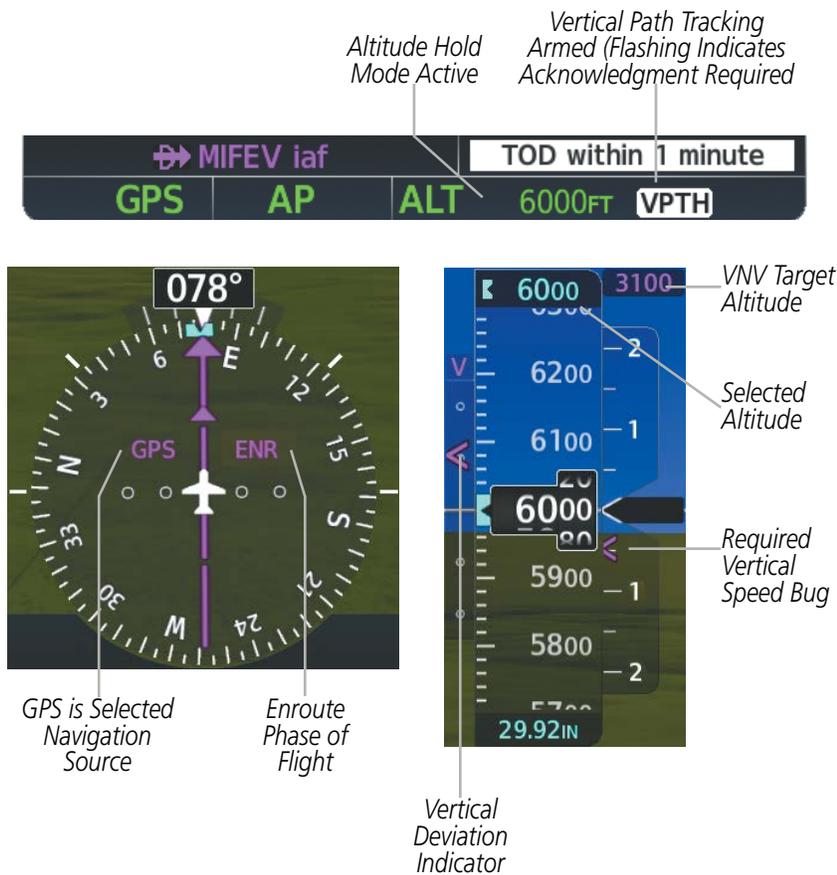


Figure 7-15 Vertical Path Capture

When a descent leg is captured (i.e., vertical deviation becomes valid), Vertical Path Tracking becomes active and tracks the descent profile. An altitude capture mode (‘ALTS’ or ‘ALTV’) is armed as appropriate.

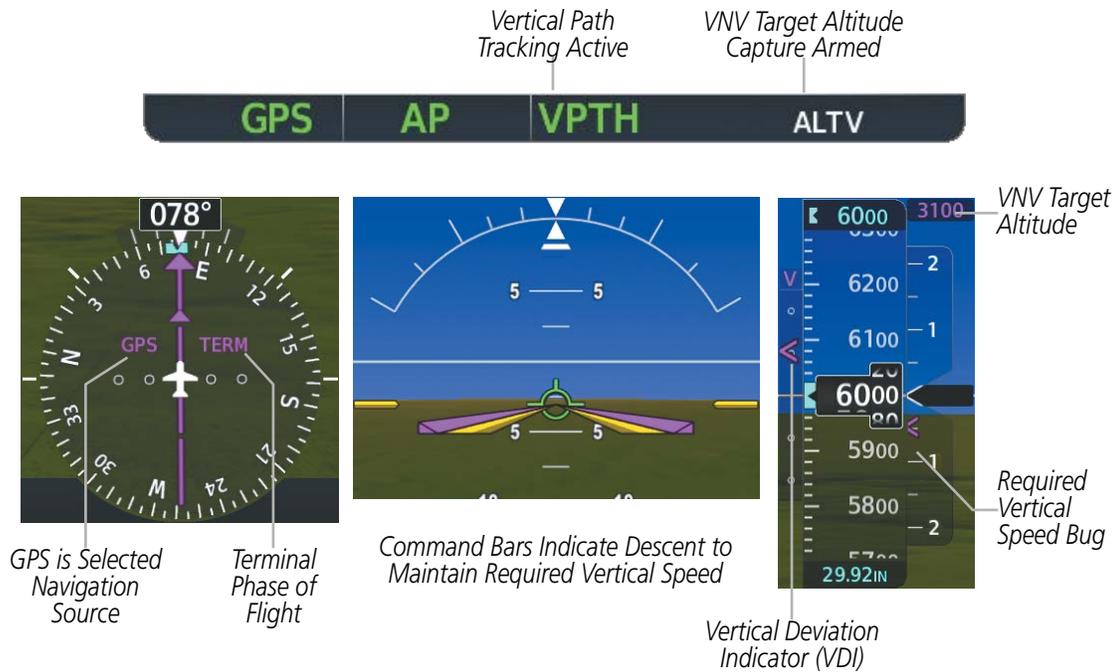


Figure 7-16 Vertical Path Tracking Mode

If the altimeter barometric setting is adjusted while Vertical Path Tracking is active, the flight director increases/decreases the descent rate by up to 500 fpm to re-establish the aircraft on the descent path (without commanding a climb). Adjusting the altimeter barometric setting creates discontinuities in VNV vertical deviation, moving the descent path. For large adjustments, it may take several minutes for the aircraft to re-establish on the descent path. If the change is made while nearing a waypoint with a VNV Target Altitude, the aircraft may not re-establish on the descent path in time to meet the vertical constraint.

Automatic Reversion to Pitch Hold Mode

Several situations can occur while Vertical Path Tracking Mode is active which cause the flight director to revert to Pitch Hold Mode:

- Vertical deviation exceeds 200 feet during an overspeed condition.
- Vertical deviation experiences a discontinuity that both exceeds 200 feet in magnitude and results in the vertical deviation exceeding 200 feet in magnitude. Such discontinuities are usually caused by flight plan changes that affect the vertical profile.
- Vertical deviation becomes invalid (the Vertical Deviation Indicator is removed from the PFD).
- A display enters Reversionary Mode (this does not apply to an active vertical direct-to).

Unless VNV is disabled, Vertical Path Tracking Mode and the appropriate altitude capture mode become armed following the reversion to Pitch Hold Mode to allow for possible profile recapture.

Non-Path Descents

Pitch Hold, Vertical Speed, and Flight Level Change modes can also be used to fly non-path descents while VNV flight control is selected. If the **VS** or **FLC** Key is pressed while Vertical Path Tracking Mode is selected, Vertical Path Tracking Mode reverts to armed along with the appropriate altitude capture mode to allow profile re-capture.

GPS | AP | **FLC** | 190KT | ALTS VPTH

Figure 7-17 Flight Level Change VNV Non-Path Descent

To prevent immediate profile re-capture, the following must be satisfied:

- At least 10 seconds have passed since the non-path transition was initiated
- Vertical deviation from the profile has exceeded 250 feet, but is now less than 200 feet

Pressing the **VNV** Key twice re-arms Vertical Path Tracking for immediate profile re-capture.

VNV TARGET ALTITUDE CAPTURE MODE (ALTV)



NOTE: VNV Target Altitude Capture Mode is only applicable to aircraft equipped with a VNV Key.



NOTE: Armed VNV Target Altitude and Selected Altitude capture modes are mutually exclusive. However, Selected Altitude Capture Mode is armed implicitly (not annunciated) whenever VNV Target Altitude Capture Mode is armed.

VNV Target Altitude Capture is analogous to Selected Altitude Capture Mode and is armed automatically after the **VNV** Key is pressed and the next VNV Target Altitude is to be intercepted before the Selected Altitude. The annunciation ‘ALTV’ indicates that the VNV Target Altitude is to be captured. VNV Target Altitudes are shown in the active flight plan or vertical direct-to, and can be entered manually or loaded from a database (see the Flight Management Section for details). At the same time as “TOD within 1 minute” is annunciated in the Navigation Status Box, the active VNV Target Altitude is displayed above the Vertical Speed Indicator (see Figure 7-15).

As the aircraft nears the VNV Target Altitude, the flight director automatically transitions to VNV Target Altitude Capture Mode with Altitude Hold Mode armed. This automatic transition is indicated by the green ‘ALTV’ annunciation flashing for up to 10 seconds and the appearance of the white ‘ALT’ annunciation. The VNV Target Altitude is shown as the Altitude Reference beside the ‘ALTV’ annunciation and remains displayed above the Vertical Speed Indicator. The Required Vertical Speed Indication (RVSI) is removed once VNV Target Altitude Capture Mode becomes active.

At 50 feet from the VNV Target Altitude, the flight director automatically transitions from VNV Target Altitude Capture to Altitude Hold Mode and tracks the level leg. As Altitude Hold Mode becomes active, the white ‘ALT’ annunciation moves to the active vertical mode field and flashes green for 10 seconds to indicate the automatic transition. The flight director automatically arms Vertical Path Tracking, allowing upcoming descent legs to be captured and subsequently tracked.

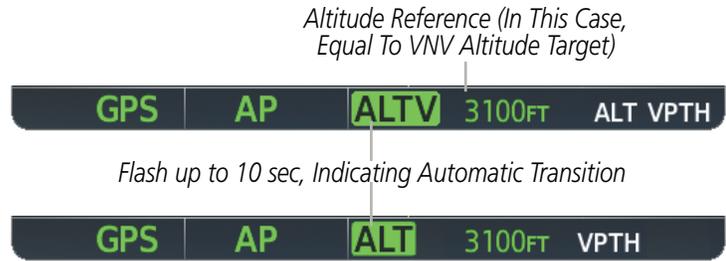


Figure 7-18 Automatic Mode Transitions During Altitude Capture

Changing the VNV Target Altitude



NOTE: Pressing the **CWS** Switch while in VNV Target Altitude Capture Mode does not cancel the mode.

Changing the current VNV Target Altitude while VNV Target Altitude Capture Mode is active causes the flight director to revert to Pitch Hold Mode. Vertical Path Tracking and the appropriate altitude capture mode are armed in preparation to capture the new VNV Target Altitude or the Selected Altitude, depending on which altitude is to be intercepted first.

VNV target altitudes can be changed while editing the active flight plan (see the Flight Management Section for details).

APPROACH MODES (GPS, VAPP, LOC)



NOTE: *The selected navigation receiver must have a valid VOR or LOC signal or active GPS course for the flight director to enter Approach Mode.*

Approach Mode is activated when the **APR** Key is pressed. Approach Mode acquires and tracks the selected navigation source (GPS, VOR, or LOC), depending on loaded approach. This mode uses the selected navigation receiver deviation and desired course inputs to fly the approach. Pressing the **APR** Key when the CDI is greater than one dot arms the selected approach mode (annunciated in white to the left of the active lateral mode). If the CDI is less the 1 dot, the LOC is automatically captured when the **APR** Key is pressed.

VOR Approach Mode (VAPP) provides greater sensitivity for signal tracking than VOR Navigation Mode.

Selecting VOR Approach Mode:

- 1) Ensure a valid VOR frequency is tuned
- 2) Ensure that VOR is the selected navigation source (use the **CDI** Softkey to cycle through navigation sources if necessary).
- 3) Press the **APR** Key.

When GPS Approach Mode is armed, Glidepath Mode is also armed.

Selecting GPS Approach Mode:

- 1) Ensure a GPS approach is loaded into the active flight plan. The active waypoint must be part of the flight plan (cannot be a direct-to a waypoint not in the flight plan).
- 2) Ensure that GPS is the selected navigation source (use the **CDI** Softkey to cycle through navigation sources if necessary).
- 3) Press the **APR** Key.



Figure 7-19 GPS Approach Mode Armed

LOC Approach Mode allows the autopilot to fly a LOC/ILS approach with a glideslope. When LOC Approach Mode is armed, Glideslope Mode is also armed automatically. LOC captures are inhibited if the difference between aircraft heading and localizer course exceeds 105°.

Selecting LOC Approach Mode:

- 1) Ensure a valid localizer frequency is tuned.
- 2) Ensure that LOC is the selected navigation source (use the **CDI** Softkey to cycle through navigation sources if necessary).
- 3) Press the **APR** Key.

Or:

SYSTEM OVERVIEW
 FLIGHT INSTRUMENTS
 EIS
 AUDIO PANEL & CNS
 FLIGHT MANAGEMENT
 HAZARD AVOIDANCE
 AFCS
 ADDITIONAL FEATURES
 APPENDICES
 INDEX

- 1) Ensure that GPS is the selected navigation source (use the **CDI** Softkey to cycle through navigation sources if necessary).
- 2) Ensure a LOC/ILS approach is loaded into the active flight plan.
- 3) Ensure the corresponding LOC frequency is tuned.
- 4) Press the **APR** Key.

If the following occurs, the flight director reverts to Roll Hold Mode (wings rolled level):

- Approach Mode is active and a Vectors-To-Final is activated
- Approach Mode is active and Navigation source is manually switched
- During a LOC/ILS approach, GPS Navigation Mode is active and the FAF is crossed after the automatic navigation source switch from GPS to LOC

CHANGING THE SELECTED COURSE

If the navigation source is VOR or localizer or OBS Mode has been enabled when using GPS, the Selected Course is controlled using the **CRS** Knob corresponding to the selected flight director (**CRS1** for the pilot side, **CRS2** for the copilot side).

Pressing the **CWS** Button and hand-flying the aircraft does not change the Selected Course while in Approach Mode. The autopilot guides the aircraft back to the Selected Course (or GPS flight plan) when the **CWS** Button is released.

GLIDEPATH MODE (GP) (SBAS ONLY)



NOTE: Pressing the **CWS** Switch while Glidepath Mode is active does not cancel the mode. The autopilot guides the aircraft back to the glidepath upon release of the **CWS** Switch.

Glidepath Mode is available only when SBAS is available. Glidepath Mode is used to track the SBAS-based glidepath. When Glidepath Mode is armed, 'GP' is annunciated in white in the AFCS Status Box.

Selecting Glidepath Mode (SBAS Only):

- 1) Ensure a GPS approach with vertical guidance or vertical descent angle (LPV, LNAV/VNAV, LNAV +V) is loaded into the active flight plan. The active waypoint must be part of the flight plan (cannot be a direct-to a waypoint not in the flight plan).
- 2) Ensure that GPS is the selected navigation source (use the **CDI** Softkey to cycle through navigation sources if necessary).
- 3) Press the **APR** Key.



NOTE: Some RNAV (GPS) approaches provide a vertical descent angle as an aid in flying a stabilized approach. These approaches are NOT considered Approaches with Vertical Guidance (APV). Approaches that are annunciated on the HSI as LNAV or LNAV+V should be flown to an MDA, until visual with the landing surface, even though vertical glidepath (GP) information may be provided.



WARNING: When flying an LNAV approach (with vertical descent angle) with the autopilot coupled, the aircraft will not level off at the MDA even if the MDA is set in the altitude preselect.

Upon reaching the glidepath, the flight director transitions to Glidepath Mode and begins to capture and track the glidepath.

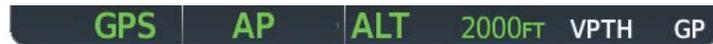


Figure 7-20 Glidepath Mode Armed

Once the following conditions have been met, the glidepath can be captured:

- A GPS approach with vertical guidance (LPV, LNAV/VNAV, LNAV+V) is loaded into the active flight plan.
- The active waypoint is at or after the final approach fix (FAF).
- Vertical deviation is valid.
- The CDI is at less than full-scale deviation
- Automatic sequencing of waypoints has not been suspended (no ‘SUSP’ annunciation on the HSI)



NOTE: Pressing the **CWS** Button while Glidepath Mode is active does not cancel the mode. The autopilot guides the aircraft back to the glidepath upon release of the **CWS** Button.

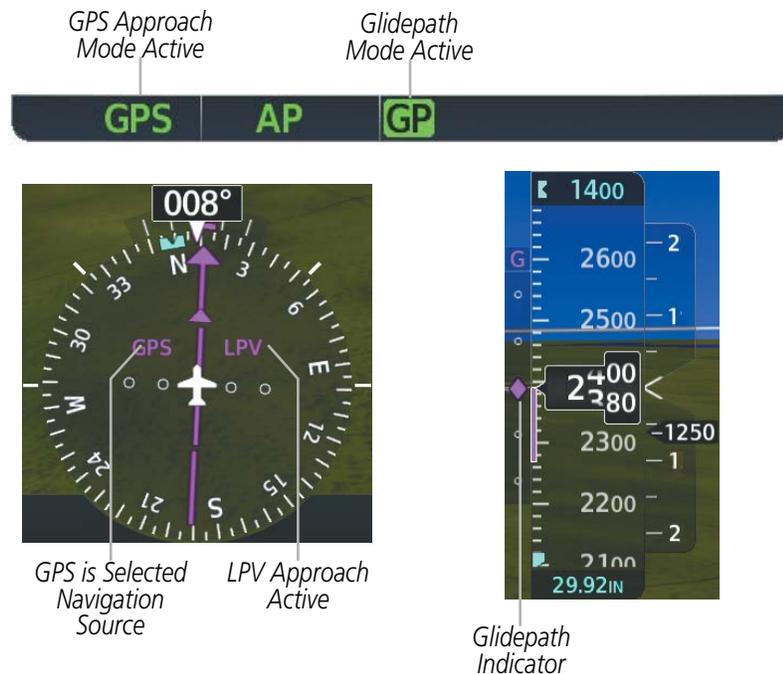


Figure 7-21 Glidepath Mode

GLIDESLOPE MODE (GS)

Glideslope Mode is available for LOC/ILS approaches to capture and track the glideslope. When Glideslope Mode is armed (annunciated as ‘GS’ in white), LOC Approach Mode is armed as the lateral flight director mode.

SYSTEM OVERVIEW
FLIGHT INSTRUMENTS
EIS
AUDIO PANEL & CNS
FLIGHT MANAGEMENT
HAZARD AVOIDANCE
AFCS
ADDITIONAL FEATURES
APPENDICES
INDEX

Selecting Glideslope Mode:

- 1) Ensure a valid localizer frequency is tuned.
 - 2) Ensure that LOC is the selected navigation source (use the **CDI** Softkey to cycle through navigation sources if necessary).
 - 3) Press the **APR** Key.
- Or:**
- 1) Ensure that GPS is the selected navigation source (use the **CDI** Softkey to cycle through navigation sources if necessary).
 - 2) Ensure a LOC/ILS approach is loaded into the active flight plan.
 - 3) Ensure the corresponding LOC frequency is tuned.
 - 4) Press the **APR** Key.



Figure 7-22 Glideslope Mode Armed

Once LOC is the navigation source, the localizer and glideslope can be captured. Upon reaching the glideslope, the flight director transitions to Glideslope Mode and begins to capture and track the glideslope.



NOTE: Pressing the **CWS** Button while Glideslope Mode is active does not cancel the mode. The autopilot guides the aircraft back to the glideslope upon release of the **CWS** Button.

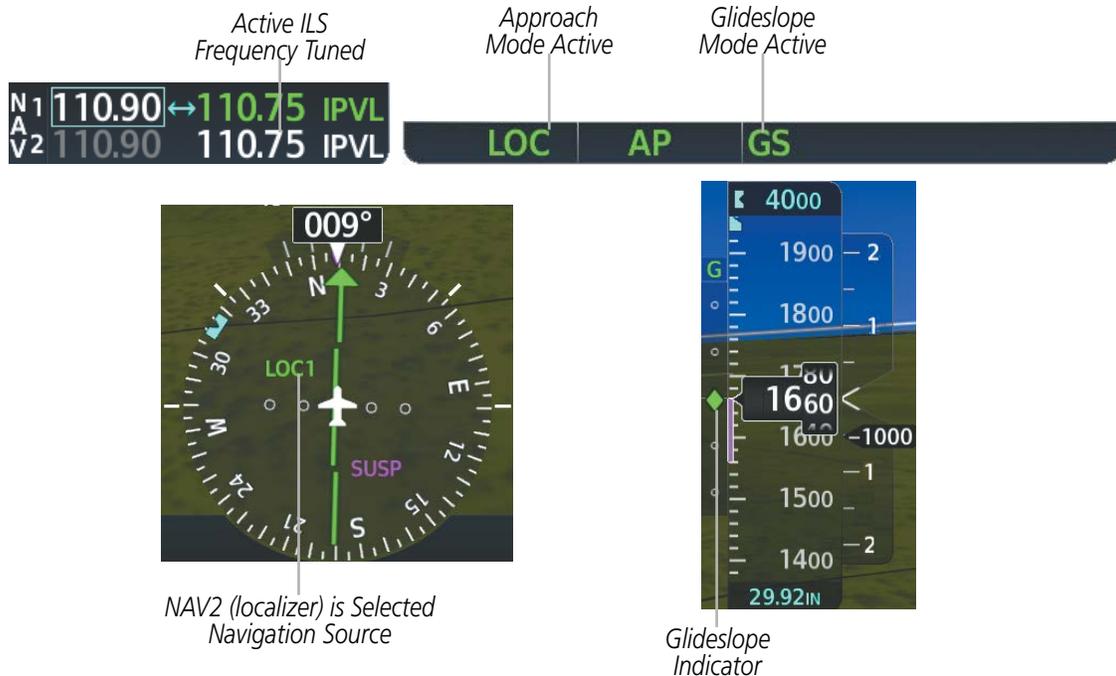


Figure 7-23 Glideslope Mode

BACKCOURSE MODE (BC)



NOTE: When making a backcourse approach, set the Selected Course to the localizer front course.

Backcourse Mode captures and tracks a localizer signal in the backcourse direction. The mode may be selected by pressing the **BC** Key. Backcourse Mode is armed if the CDI is greater than one dot when the mode is selected. If the CDI is less than one dot, Backcourse Mode is automatically captured when the **BC** Key is pressed. The flight director creates roll steering commands from the Selected Course and deviation when in Backcourse Mode.



Figure 7-24 Backcourse Mode

CHANGING THE SELECTED COURSE

If the navigation source is VOR or localizer or OBS Mode has been enabled when using GPS, the Selected Course is controlled using the **CRS** Knob corresponding to the selected flight director (**CRS1** for the pilot side, **CRS2** for the copilot side).

Pressing the **CWS** Button and hand-flying the aircraft does not reset any reference data while in Backcourse Mode. The autopilot guides the aircraft back to the Selected Course when the **CWS** Button is released.

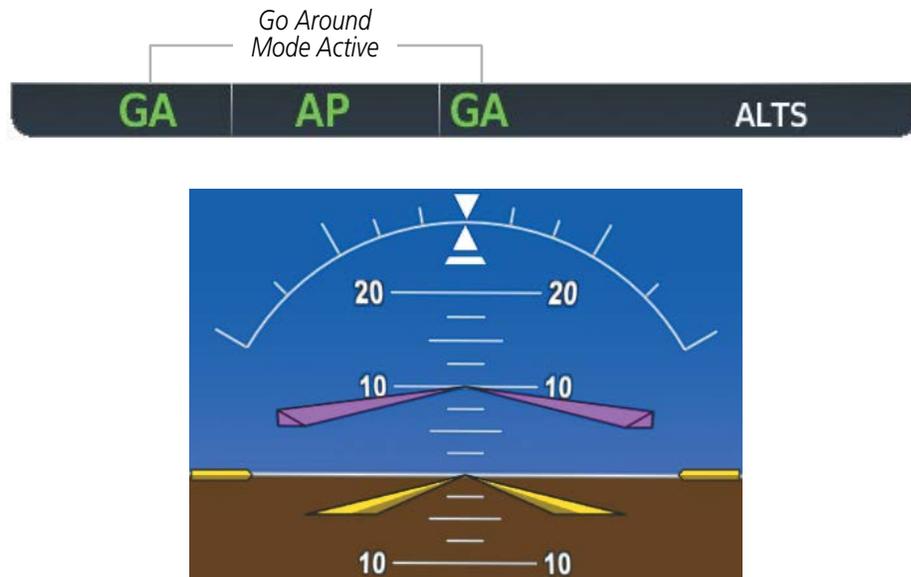
INTERCEPTING AND FLYING A DME ARC

The AFCS will intercept and track a DME arc that is part of the active flight plan provided that GPS Navigation Mode is engaged, GPS is the active navigation source on the CDI, and the DME arc segment is the active flight plan leg. It is important to note that automatic navigation of DME arcs is based on GPS. Thus, even if the **APR** key is pressed and **LOC** or **VOR** Approach Mode is armed prior to reaching the Initial Approach Fix (IAF), Approach Mode will not activate until the arc segment is completed.

If the pilot decides to intercept the arc at a location other than the published IAF (i.e. ATC provides vectors to intercept the arc) and subsequently selects Heading Mode or Roll Mode, the AFCS will not automatically intercept or track the arc unless the pilot activates the arc leg of the flight plan and arms GPS Navigation Mode. The AFCS will not intercept and fly a DME arc before reaching an IAF that defines the beginning of the arc segment. Likewise, if at any point while established on the DME arc the pilot deselects GPS Navigation Mode, the AFCS will no longer track the arc.

GO AROUND (GA) MODES

Pressing the **GA** Switch while in the air activates the flight director in a wings-level, pitch-up attitude, allowing the execution of a missed approach or a go around. Go Around Mode disengages the autopilot and arms Selected Altitude Capture Mode automatically. Subsequent autopilot engagement is allowed. Attempts to modify the aircraft attitude (i.e., with the **NOSE UP/NOSE DN** Keys or **CWS** Switch) result in reversion to Pitch and Roll Hold modes.



Command Bars Indicate Climb

Figure 7-25 Go Around Modes

7.4 AUTOPILOT



NOTE: Refer to the POH for specific instructions regarding emergency procedures.

The autopilot operates flight control surface servos to provide automatic flight control. Pitch and roll commands are provided to the servos, based on the active flight director modes. The autopilot uses pitch and roll rates to stabilize the aircraft attitude during upsets and flight director maneuvers. Flight director commands are rate- and attitude-limited, combined with pitch and roll damper control, and sent to the pitch and roll servo motors.

Pitch autotrim provides trim commands to the pitch trim servo to relieve any sustained effort required by the pitch servo. The pitch servo measures the output effort (torque) and provides this signal to the pitch trim servo. The pitch trim servo commands the motor to reduce the average pitch servo effort.

When the autopilot is not engaged, the pitch trim servo may be used to provide manual electric trim (MET). This allows the aircraft to be trimmed using a control wheel switch rather than the trim wheel. Manual trim commands are generated with the **MET** Switch. Trim speeds are scheduled with airspeed to provide more consistent response.

Servo motor control limits the maximum servo speed and torque. The servo mounts are equipped with slip-clutches set to certain values. This allows the servos to be overridden in case of an emergency.

FLIGHT CONTROL

Pitch and roll commands are provided to the servos based on the active flight director modes. Yaw damping is provided by the yaw servo. Servo motor control limits the maximum servo speed and torque. The servo mounts are equipped with slip-clutches set to certain values. This allows the servos to be overridden in case of an emergency.

PITCH AXIS AND TRIM

The autopilot pitch axis uses pitch rate to stabilize the aircraft pitch attitude during flight director maneuvers. Flight director pitch commands are rate and attitude-limited, combined with pitch damper control, and sent to the pitch servo motor. The pitch servo measures the output effort (torque) and provides this signal to the pitch trim servo. The pitch trim servo commands the motor to reduce the average pitch servo effort.

When the autopilot is not engaged, the pitch trim servo may be used to provide manual electric pitch trim (MET). This allows the aircraft to be trimmed using a control wheel switch rather than the trim wheel. Manual trim commands are generated only when both halves of the **MET** Switch are operated simultaneously. Trim speeds are scheduled with airspeed to provide more consistent response.

ROLL AXIS

The autopilot roll axis uses roll rate to stabilize aircraft roll attitude during flight director maneuvers. The flight director roll commands are rate- and attitude-limited, combined with roll damper control, and sent to the roll servo motor.

ENGAGEMENT

NOTE: Autopilot engagement/disengagement is not equivalent to servo engagement/disengagement. Use the **CWS** Switch to disengage the pitch and roll servos while the autopilot remains active.

When the **AP** Key is pressed, the autopilot and flight director (if not already engaged) are activated. Engagement is indicated by a green 'AP' annunciation in the center of the AFCS Status Box. The flight director engages in Pitch and Roll Hold modes when initially activated.



Figure 7-26 Autopilot and Yaw Damper Engaged

CONTROL WHEEL STEERING

During autopilot operation, the aircraft may be hand-flown without disengaging the autopilot. Pressing and holding the **CWS** Button disengages the pitch and roll servos from the flight control surfaces and allows the aircraft to be hand-flown. At the same time, the flight director is synchronized to the aircraft attitude during the maneuver. The 'AP' annunciation is temporarily replaced by 'CWS' in white for the duration of CWS maneuvers.

In most scenarios, releasing the **CWS** Button reengages the autopilot with a new reference. Refer to the flight director modes section for CWS behavior in each mode.



Figure 7-27 CWS Annunciation

DISENGAGEMENT

The autopilot is manually disengaged by pushing the **AP DISC** Switch, **AP** Key on the MFD, **GA** Switch, or **MET ARM** Switch. Manual autopilot disengagement is indicated by a five-second flashing yellow 'AP' annunciation and a three-second autopilot disconnect aural alert.



Figure 7-28 Manual Autopilot Disengagement

Pushing the **AP DISC** Switch disengages the autopilot. When the autopilot is manually disengaged, the 'AP' annunciation turns yellow and flashes for 5 seconds and a three-second autopilot disconnect aural alert is generated.



Figure 7-29 Yaw Damper Disengagement

After manual disengagement, the autopilot disconnect aural alert may be cancelled by pushing the **MET ARM** or **AP DISC** Switch (**AP DISC** Switch also cancels the flashing 'AP' annunciation).

Automatic autopilot disengagement is indicated by a flashing red and white 'AP' annunciation and by the autopilot disconnect aural alert, which continue until acknowledged by pushing the **AP DISC** or **MET ARM** Switch. Automatic autopilot disengagement occurs due to:

- System failure
- Inability to compute default flight director modes (FD also disengages automatically)
- Invalid sensor data

7.5 AFCS ANNUNCIATIONS AND ALERTS

AFCS CAS MESSAGES

The annunciations in Table 7-6 (listed in order of increasing priority) can appear on the PFDs above the Airspeed and Attitude indicators. Only one annunciation may occur at a time, and messages are prioritized by criticality.



Figure 7-31 AFCS Status Annunciation

Alert Condition	Annunciation	Description
Aileron Mistrim Right	AIL→	Roll servo providing sustained force in the indicated direction
Aileron Mistrim Left	←AIL	
Elevator Mistrim Down	↓ELE	Pitch servo providing sustained force in the indicated direction
Elevator Mistrim Up	↑ELE	
Pitch Trim Failure (or stuck MET Switch)	PTRM	If AP engaged, take control of the aircraft and disengage AP If AP disengaged, move MET switches separately to unstick
Roll Failure	ROLL	Roll axis control failure; AP inoperative
Pitch Failure	PTCH	Pitch axis control failure; AP inoperative
System Failure	AFCS	AP and MET are unavailable; FD may still be available
Preflight Test	PFT	Performing preflight system test; aural alert sounds at completion Do not press the AP DISC Switch during servo power-up and preflight system tests as this may cause the preflight system test to fail or never to start (if servos fail their power-up tests). Power must be cycled to the servos to remedy the situation.
	PFT	Preflight system test failed; aural alert sounds at failure

Table 7-6 AFCS Status Alerts

OVERSPEED PROTECTION

NOTE: Overspeed protection is not active in ALT, GS or GP modes.

While Pitch Hold, Vertical Speed, Flight Level Change, Vertical Path Tracking, or an altitude capture mode is active, airspeed is monitored by the flight director. Overspeed protection is provided to limit the flight director's pitch command in situations where the flight director cannot acquire and maintain the mode reference for the selected vertical mode without exceeding Vne.

When Overspeed Protection is active, the Airspeed Reference appears in a box above the Airspeed Indicator, flashing a yellow 'MAXSPD' annunciation. Engine power should be reduced and/or the pitch reference adjusted to slow the aircraft. The annunciation disappears when the overspeed condition is resolved.

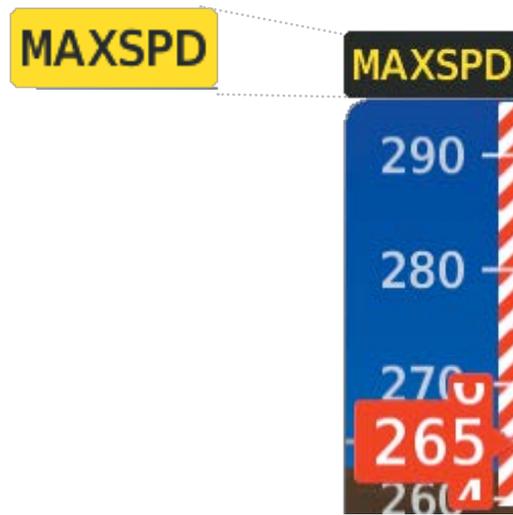


Figure 7-32 Overspeed Annunciation

- SYSTEM OVERVIEW
- FLIGHT INSTRUMENTS
- EIS
- AUDIO PANEL & CNS
- FLIGHT MANAGEMENT
- HAZARD AVOIDANCE
- AFCS
- ADDITIONAL FEATURES
- APPENDICES
- INDEX